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Region 2 RAC2
Remedial Action Contract

Final Feasibility Study Report

Wolff-Alport Chemical Company Site

Remedial Investigation/Feasibility Study

Ridgewood, Queens, New York

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503969

CDM Smith

Table of Contents

List of Tables

List of Figures

Appendices

Acronyms, Abbreviations, and Symbols

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µR/hr	micro Roentgen per hour
≤	less than or equal to
>	greater than
°C	degrees Celsius
°F	degrees Fahrenheit
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BAP	benzo(a)pyrene
BCG	biota concentration guide
bgs	below ground surface
C&D	construction and disposal
CAA	Clean Air Act
CDM Smith	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	contaminant of concern
COPC	chemical of potential concern
cpm	counts per minute
cm^2	square centimeter
CSM	conceptual site model
CSO	combined sewer overflow
CSS	combined sewer system
CTE	central tendency exposure
CVOC	chlorinated volatile organic compound
cy	cubic yard
DOE	Department of Energy
dpm	disintegrations per minute
EC	engineering control
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GPS	Global Positioning System
GRA	general response action
HHRA	human health risk assessment
HI	hazard index
IC	institutional control
LBA	Louis Berger & Associates
LDR	Land Disposal Restriction
LLMW	low-level mixed waste
LTTD	low temperature thermal desorption
M	million
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

mg/kg	milligrams per kilogram
MCL	maximum contaminant level
mrem	milli Roentgen equivalent man
msl	mean sea level
NARM	naturally occurring and/or accelerator-produced radioactive material
NCP	National Contingency Plan
NRC	Nuclear Regulatory Commission
NRDCSCC	Non-Residential Direct Soil Cleanup Criteria
NYCDDC	New York Department of Design and Construction
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PPE	personal protective equipment
ppm	parts per million
PRG	preliminary remediation goal
ppm	parts per million
P.S./I.S.	public elementary and intermediate school
PTW	principal threat waste
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RESRAD	RESidual RADioactivity, DOE computer model
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROC	radionuclides of concern
ROD	Record of Decision
ROPC	radionuclides of potential concern
RSL	Regional Screening Level
S/S	solidification/stabilization
site	Wolff-Alport Chemical Company Superfund Site
SLERA	screening level ecological risk assessment
TBC	to be considered
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
Th-232	thorium-232
T/M/V	toxicity/mobility/volume
TSCA	Toxic Substances Control Act
U-238	uranium-238
USC	United States Code
UST	underground storage tank
UTL	upper tolerance level

VISL	Vapor Intrusion Screening Levels
VOC	volatile organic compound
WACC	Wolff-Alport Chemical Company

Executive Summary

CDM Federal Programs Corporation (CDM Smith) received Work Assignment 054-RICO-A282 under the U.S. Environmental Protection Agency (EPA), Remediation Action Contract 2 (RAC 2) to complete a remedial investigation/feasibility study (RI/FS) for the Wolff-Alport Chemical Company (WACC) Superfund Site (the site) located in Ridgewood, Queens, New York. The lead agency for the site is EPA Region 2.

The purpose of the feasibility study (FS) is to identify, develop, screen, and evaluate a range of remedial alternatives for the contaminated media and provide the regulatory agencies with sufficient information to select a feasible and cost-effective remedial alternative that protects public health and the environment from potential risks at the site.

ES.1 Site Description

The WACC site is located in Ridgewood, Queens County, New York, at the county border with Brooklyn (See **Figure 1-1**). The site includes the former WACC property that is now subdivided into several properties of Block 3725, as well as adjacent areas including streets, sidewalks, buildings, and the sewer system where contaminants have migrated or have the potential to migrate from the WACC property.

The WACC property is the triangular property situated on Lots 31 (partial), 33, 42, 44, 46, and 48 (see **Figure 1-2**) and covers approximately 0.75 acre bounded by Irving Avenue to the southwest, Cooper Avenue to the northwest, and an active cabinet manufacturer (5606 Cooper Avenue) to the east. At present, the property is covered with contiguous structures, except along its eastern edge in the former rail spur area. The neighborhoods surrounding the WACC property contain light industry, commercial businesses, residences, a school, and a daycare. An active rail line passes within 125 feet to the southeast of the property; the Cemetery of the Evergreens is located to the east and south of the rail line and covers over 225 acres.

ES.2 Site History

WACC operated at the property from the 1920s until 1954, importing monazite sand via rail and extracting rare earth metals from the material. Monazite sand contains approximately 6% to 8% or more of thorium and 0.1% to 0.3% of uranium. The acid treatment process of the monazite sands converts the phosphate and metal component of the monazite to aqueous species, rendering the rare-earth materials extractable while dissolving the thorium and uranium in a sulfuric acid waste process liquor and generating tailings. This process concentrated the thorium-232 (Th-232) and uranium-238 (U-238) in the process liquors,

Until 1947, WACC disposed of the waste from monazite sand processing in the sewer (process liquors) and possibly by burial/spreading on the property (waste tailings). During its years of operation, WACC occupied three structures at 1127 Irving Avenue (currently lots 42 and 44). The WACC operation included two yard areas: one between the company's buildings at Lot 42 and the other on the eastern end of the property at the northern end of Moffat Street at Lot 33. These former yard areas were reportedly used as staging areas for monazite sands or waste tailings containing Th-232 and U-238. WACC did not operate at Lot 46 or Lot 48, but those properties are affected by the radioactive materials associated with the site.

According to the U.S. Department of Energy (DOE), the Atomic Energy Commission (AEC) ordered WACC to halt sewer disposal of thorium waste in the fall of 1947. Thereafter, Th-232 was precipitated as thorium-oxalate sludge and sold to the AEC.

ES.3 Physical Setting

The WACC property is at an elevation of approximately 70 feet above mean sea level (msl), and the ground surface in the area generally slopes gently to the southwest. The eastern edge of the site is adjacent to an elevated train line parallel to Moffat Street. The ground surface rises sharply toward the train line and continues to rise to the cemetery east of the site to elevations as high as 160 feet above msl.

The site is in a highly urbanized area, where infiltration of precipitation is largely restricted due to the high percentage of ground surface covered by pavement and buildings. Storm water in the majority of the site area is directed into catch basins that connect to a combined sewer system (CSS). The WACC property is located at the head of a branch of the sewer system. The sewer flows away from the property to the west down Irving Avenue before turning on Halsey Street and joining larger sewers on Wyckoff Avenue. During large storms, these sewers discharge directly into the East Branch of Newtown Creek, which is approximately 1.9 miles from the WACC property.

Drilling advanced into the upper portion of the aquifer in this area and encountered two types of unconsolidated material: fill and Upper Glacial Aquifer deposits (till and outwash). Fill near the WACC property is typically 5-15 feet thick and is generally characterized by the presence of man-made materials (brick, coal, various building materials) intermixed with silt, sands, and gravels. The distinction between fill and the underlying glacial material was difficult when man-made debris was not present in the soil. This is representative of regrading of native materials within the area.

Soil borings at the site generally indicate the presence of Upper Glacial Aquifer soils extending from the bottom of fill (0-15 feet below ground surface (bgs)) to beyond the deepest boring performed at the site (75 feet bgs). The interpreted total thickness of the Upper Glacial Aquifer soils in the site area is about 170 feet. The Magothy Formation is absent at the site and the Upper Glacial Aquifer is underlain by the Gardiners Clay (approximately 50 feet thick), which is in turn underlain by the Raritan Clay (approximately 130 feet thick). The Lloyd aquifer is approximately 40 feet thick, and the bedrock surface is expected to be encountered at a depth of about 390 feet bgs, although some sources have estimated this depth to be closer to 450 feet bgs.

Depth to water at the site is about 60 feet bgs (12 feet amsl). The base of the Upper Glacial Aquifer in this area is assumed to be the Gardiners Clay, which is present at elevation 100 feet below msl at the site, or about 170 feet bgs. The saturated thickness of the aquifer is estimated to be about 111-114 feet, based on the depth to water at each well.

The gradient direction at the water table is generally to the south and the horizontal gradient is gentle, about 0.0006 feet per linear foot.

The hydraulic conductivity of the upper 10 feet of the Upper Glacial Aquifer in this area was estimated to be about 30 feet/day by slug tests during the RI (CDM Smith 2017a). This is consistent with published values for fine to coarse sand, but is much lower than published values for the outwash deposits of the upper glacial aquifer, e.g., 270 feet/day (Soren 1971). Based upon the measured horizontal hydraulic gradient, the estimated hydraulic conductivity and an assumed porosity of 20 percent, the seepage velocity of the shallow groundwater is estimated to be 0.09 foot per day.

ES.4 Nature and Extent of Contamination

CDM Smith performed the RI field investigation between September 18, 2015 and November 17, 2016, and March to April 2017 (CDM Smith 2017a) to address data gaps identified through review of previous investigations, in support of characterization of the nature and extent of contamination in building materials, soil, sewers and sewer sediments, creek sediments, groundwater, and air (CDM Smith 2017a).

As noted in Section ES.2, the acid treatment process of monazite sands converts the phosphate and metal component of the monazite to aqueous species, rendering the rare-earth materials extractable while dissolving the thorium and uranium in an acid waste process liquor and generating tailings. Monazite sand contains, by weight per cent, approximately 6% to 8% of thorium and 0.1% to 0.3% of uranium. The Th-232 and U-238 are categorized as decay chain radionuclides and as such their presence is accompanied by the decay progeny which in turn are also radioactive. Radon is a radioactive noble gas whose isotopes are present in both decay chains. Th-232 is the most stable thorium isotope whose decay chain includes the radon isotope Radon-220, commonly referred to as thoron. The U-238 decay chain includes Ra-226 and the radon isotope Radon-222, commonly referred to as radon.

The nature and extent of contamination in site media was assessed by comparing sample results to radiological and chemical screening criteria developed during the RI (CDM Smith 2017a). The RI screening criteria are presented in **Appendix A**. The nature and extent of contamination discussed below focuses on those radionuclides and chemicals that most frequently exceeded screening criteria and were not likely attributable to another source which included: radionuclides found in all media throughout the site, BAP in soil, and PCBs in soil.

ES.4.1 Building Materials

Contamination remains in the building structures at the WACC property, primarily in the buildings that previously operated the kiln/vat in which monazite sands processing took place (Lots 42 and 44), in the basement of the deli (Lot 46), and, to a much lesser extent, in the warehouse on Lot 33 constructed above the former yard area. Contaminants are primarily embedded in the building structure with the highest concentration of Th-232 at 415.2 picocurie per gram (pCi/g) and Radium-226 (Ra-226) at 44.2 pCi/g on a sample of brick from Lot 44.

Asbestos-containing material, lead based paint, and other suspect hazardous materials were also found in the WACC building structures and were comparable to a building of its age

ES.4.2 Air

Air sampling from previous investigations and RI was used to evaluate the nature and extent of radon and thoron contamination at the Site.

ES.4.2.1 WACC Buildings – Indoor Air

A previous investigation conducted on behalf of NYCDDC in 2010 found an elevated thoron concentration of 12.7 pCi/L in the basement of the deli located on Lot 46. Two other areas surveyed included the Primo Auto Body shop on Lot 42 and the Celtic Bike Shop on Lot 44. The maximum radon and thoron concentrations from these areas, respectively, were 1.4 pCi/L and 1.6 pCi/L of radon and 0.8 pCi/L and 1.8 pCi/L of thoron.

A previous investigation conducted as part of the radiation mitigation activities conducted in 2012 and 2013 collected air samples for radon before and after radiation mitigation measures (including shielding and a radon mitigation system) were installed. Air sampling conducted prior to radiation mitigation activities found the highest levels of indoor air contamination in Lots 42, 44, and 46 (where the majority of the WACC processing activities took place), at concentrations greater than the RI first floor indoor air radon screening criterion of 0.5 pCi/L, with concentrations up to 4.6 pCi/L (Weston 2016). Following radon mitigation activities, the radon levels inside Lot 42 TerraNova remained greater than the RI indoor air screening criterion (0.5 pCi/L) at 1.5 pCi/g. The follow up series of 2-hour continuous measurements at the same location in course of 5 days showed several instances of gas concentration increases lasting 8 – 16 hours followed gradual decreases of the same time length. The concentration fluctuations of the gas influx were recorded about 2 orders of magnitude and, over 5-day period, yielded average radon and thoron concentrations as 4.73 pCi/L and 3.41 pCi/L, respectively.

ES.4.2.2 WACC Property – Outdoor Air

Thoron and radon sampling was conducted outside the WACC buildings in a 2012 neighborhood radiological assessment by New York State Department of Health, New York City Department of Health and Mental Hygiene and the EPA. According to the radon/thoron survey information and results, the highest thoron average concentration from a single location was 0.303 pCi/L at the corner of Cooper Street and Irving Avenue. The radon data were not available in the report.

Thoron and radon sampling conducted as part of an EPA investigation in 2013 (EPA 2013a) found the highest thoron concentrations from a location near the concrete pad in the former rail spur area. The thoron concentrations in this area ranged from 1.4 pCi/L to 172 pCi/L. The associated radon concentrations ranged from 0.1 pCi/L to 0.3 pCi/L.

ES.4.2.3 338-348 and 350 Moffat Street

A supplemental investigation was performed at the 338-348/350 Moffat Street properties by EPA in 2015 for indoor and outdoor radon and thoron (EPA 2015) to determine the air concentrations at this potentially impacted commercial and residential property. Multiple locations were surveyed based on the available external gamma rate readings, presence of cracks, holes in the floors, joints between floors and walls, and other features conducive to the emanation of gas from soil.

The maximum average thoron concentration inside of a residential condominium unit was 3.6 pCi/L, with an associated average radon concentration of 0.5 pCi/L. The investigation revealed a higher thoron concentration at 8.5 pCi/L in a shed-like structure containing a pottery workshop in the backyard of the property. The associated radon concentration was 0.4 pCi/L.

ES.4.2.4 School and Daycare

To determine potential impacts to the P.S./I.S. 384 school and the Audrey Johnson Daycare in the neighborhood of the WACC property, investigations were conducted at the properties. As part of previous EPA investigations, single gas entry points were identified at the school and the daycare. The 30-minute survey using a RAD-7 meter of the single gas entry point in the school basement indicated a radon concentration of 17.9 pCi/L and a thoron concentration of 24.4 pCi/L (December 2010-January 2011). These investigations also reported elevated levels of thoron above the RI screening criterion in the switch room of the daycare's basement. The 2-hour survey of this single gas entry point indicated a radon concentration of 0.6 pCi/L and a thoron concentration of 2.1 pCi/L (December 2012) (EPA 2013a).

As part of the 2015 investigation activities, short-term radon testing was performed at the school and daycare, and long-term radon and thoron testing was performed at school. Short-term radon concentrations in the school ranged from 0.1 pCi/L to 0.4 pCi/L and in the daycare from 0.2 pCi/L to 0.7 pCi/L. All short-term radon concentrations were below the first-floor screening criterion except for one location (first floor, Room 4) at the daycare, which had radon concentration of 0.7 pCi/L. One-year radon and thoron measurements were only collected in the school. Radon concentrations ranged from 0.1 pCi/L to 1.2 pCi/L, with no samples exceeding the RI screening criterion. Thoron was only detected in one year-long sample at 0.1 pCi/L which is equal to the RI screening criterion (0.1 pCi/L).

In March 2017, continuous radon and thoron samples were collected at the daycare. A 7-day continuous air survey conducted with the RAD-7 meter measured an average radon concentration of 0.3 pCi/L, which is below the radon basement RI screening criterion of 1.2 pCi/L. A 5-day continuous air survey was also conducted with the RAD-7 meter in thoron test mode; it measured an average thoron concentration of 0.6 pCi/L, which is greater than the RI screening criterion (0.1 pCi/L). This screening criterion is conservative since it is based on outdoor data collected as part of a perimeter survey in the absence of indoor data.

ES.4.3 Soils

The soil RI investigation included gamma scan surveys, soil boring downhole gamma scans, and soil sampling to delineate the impacted soils at the WACC property and potentially impacted nearby properties. Soil sampling was also conducted for non-radiological parameters to determine if the site had other contamination.

ES.4.3.1 WACC Buildings

Radiological contamination under the WACC property buildings was encountered during previous investigations and the RI investigation. The RI screening criteria for Th-232 and Ra-226 was 1.2 pCi/g and 0.9 pCi/g, respectively. Surficial contamination (0-2 feet bgs) was found below the building on Lot 33 with a maximum Th-232 concentration of 77.4 pCi/g. The associated Ra-226 concentration for this sample was 20.7 pCi/g.

Deep contamination was found below the buildings on Lot 42 (Primo Auto Body) and Lot 44 (Celtic Bike Shop). The deep contamination extends to a depth of 28 feet below ground surface (bgs) under Lot 44 and down to 24 feet bgs under Lot 42. The highest Th-232 concentrations observed during the RI were found in this area with maximum concentrations of 760 pCi/g and 533.8 pCi/g found below Lot 42 at 6-8 feet bgs and 10-12 feet bgs, respectively. The associated Ra-226 concentrations for these samples were 1.46 pCi/g and 2.36 pCi/g, respectively.

Concentrations of benzo(a)pyrene (BAP) and polychlorinated biphenyls (PCBs) (Aroclor 1260) were found above their respective screening criterion of 16 µg/kg, and 240 µg/kg, respectively. Several metals were also found above their screening criteria but were mostly comparable to background indicating that the metals are likely associated with the urban fill or naturally occurring in glacial soils.

ES.4.3.2 Former Rail Spur and Streets

Surficial radiological contamination was observed in the former rail spur area and in the southeastern corner of Lot 31/northern area of 350 Moffat Street (area adjacent to the Irving Avenue/Moffat Street intersection). Soil borings advanced in the southern portion of Lot 31 adjacent to the Irving Avenue/Moffat Street intersection showed elevated levels of Th-232 in surficial soil samples. The maximum concentration was 19.3 pCi/g.

Irving Avenue east of the Irving Avenue/Moffat Street intersection likely contains deep contamination associated with disposal of contaminated process liquors in the sewer line in this area that may have leaked to the surrounding soils. One sample collected during the RI had a Th-232 concentration of 5 pCi/g and a Ra-226 concentration of 1.15 pCi/g. Two previous sample locations contained deeper contamination from 16 to 20 feet bgs.

The Irving Avenue/Moffat Street intersection had the highest gamma scan readings outside of the WACC property. Deeper contamination down to 8 feet bgs was observed at the intersection and the northern portion of Moffat Street at a concentration of 3.31 pCi/g of Th-232 and 2.31 pCi/g of Ra-226. Soil samples from a soil boring advanced in the middle of the intersection of the two streets (SB-50) found 209.93 pCi/g of Th-232 and 38.65 pCi/g of Ra-226 in the top 1 foot of soil.

Levels of contamination on Moffat Street moving south away from the WACC property generally decreased. Elevated concentrations of Th-232 and Ra-226 were observed in mostly surficial samples collected from 0 to 2 feet bgs. Two soil borings located in gamma reading hotspots had elevated surficial Th-232 at 28.55 pCi/g and 59.35 pCi/g and Ra-226 at 5.55 pCi/g and 11.13 pCi/g, respectively. Soil observations at these locations showed potential waste tailings in the top foot of soil. Approximately 40 feet south from the hotspot on Moffat Street, gamma readings drop to just above or within background levels.

ES.4.3.3 School and Daycare

Four of the 30 school area soil samples were slightly above the RI screening criterion for Th-232 (1.2 pCi/g), with a maximum concentration of 1.6 pCi/g. Ra-226 was not detected above the screening criterion. Because a likely source of the previously detected high concentrations of thoron and radon at the school and daycare could not be identified during the 2015 field activities at the properties, additional investigation (including soil boring sample collection and continuous radon and thoron sample collection) was performed at the end of March 2017. Results from soil samples collected below the school's basement and below the daycare's basement were all below the RI screening criteria for Th-232 and Ra-226. In the three borings installed adjacent to the daycare building on the Moffat Street sidewalk, Th-232 exceeded the RI screening criterion in one sample which was collected from 6 to 8 feet bgs at SCSB-19. Ra-226 exceeded the RI screening criterion in three samples, ranging from 0.98 pCi/g to 1.18 pCi/g. The RI concluded that these concentrations are more likely due to varied fill material in the subsurface in this area with naturally occurring higher radionuclide concentrations. The surface soil samples at these locations were all below the RI screening criteria.

ES.4.3.4 308 Cooper Street

A gamma walk-over survey at 308 Cooper Street showed most of the activity at this property is only slightly above background levels, except the northeastern corner of the property, which had readings at least twice background levels. Results from a boring in the eastern corner of this property showed Th-232 and Ra-226 concentrations above the screening criteria at 6.4 pCi/g and 1.7 pCi/g, respectively, in the surficial soil sample.

ES.4.3.5 338-348 and 350 Moffat

Gamma readings at this property were mostly within background levels. Soil samples collected from borings through the floors of the property buildings showed slightly elevated concentrations but less than 2 times the screening criteria of both Th-232 and Ra-226 from 0 to 10 feet bgs. The maximum concentrations of Th-232 and Ra-226 were 2.4 pCi/g and Ra-226 1.8 pCi/g, respectively.

Soil sampling results showed Th-232 concentrations were slightly elevated, but less than two times the screening criterion, in a majority of the soil samples. However, toward the northeast corner of the building adjacent to the southern corner of Lot 31, soil gamma readings were elevated with counts greater than four times background. A soil sample collected from 0 to 2 feet bgs in this area had Th-232 at 4.9 pCi/g, and Ra-226 at 3.2 pCi/g, confirming the gamma scan reading.

These buildings were not present when WACC was in operation. The low levels of soil contamination may indicate that contaminants from the WACC property migrated offsite due to surficial runoff into this area or that contaminated soils were used to grade and fill the area prior to construction of the buildings.

ES.4.4 Sewers

The sewer investigation found significant radionuclide contamination present in the CSS originating at the WACC property. Gamma count measurements were significantly elevated (gamma levels greater than 100,000 cpm) in the manholes south of the WACC buildings on Irving Avenue where process liquors containing Th-232 were likely discharged. The elevated gamma counts (greater than [>] 20 times background) continue in the sewer line and manholes on Irving Avenue for approximately two blocks to Decatur Street. Gamma levels within the CSS generally drop to four times background at the intersection of Irving Avenue and Schaeffer Street and drop to background at the intersection of Irving Avenue and Eldert Street, with sporadic occurrences of gamma levels above four times background continuing in the sewer along Halsey Street to Wyckoff Avenue.

Radionuclide contamination within the pipes and the manholes is present in sediments and construction materials in the sewer manholes near the WACC property. The maximum radionuclide concentrations in sewer manhole construction materials were found in manhole I-4, located near the intersection of Irving Avenue and Cooper Avenue, with Th-232 at 2,536.2 pCi/g and Ra-226 at 163.1 pCi/g. The maximum Th-232 concentration in sewer sediments was observed in manhole I-2, located south of the WACC property on Irving Avenue, with Th-232 at 1,218.1 pCi/g and Ra-226 at 45.9 pCi/g.

Radionuclide contamination (Th-232, Ra-226) appeared limited to the interior of the sewers as soil borings installed adjacent to the sewer lines found only limited radionuclide contamination. However, the bedding material below the sewers may be contaminated as the sewer fiberscope survey confirmed that there are breaks in the pipeline along Irving Avenue.

Sewer outfall - Newtown Creek sediment - Sediment concentrations at the Newtown Creek sewer outfall were above the Th-232 screening criterion with a maximum concentration of 70.2 pCi/g from 5 to 6 feet below the bottom of the river. Samples exceeding the criterion were limited to the area immediately adjacent to the outfall discharge.

ES.4.5 Groundwater

Th-232 contamination in the groundwater was limited to one groundwater sample that only slightly exceeded the screening criterion for Th-232/Ra-226 (5 pCi/L) during the Round 2 sampling at 11 pCi/L. However, Round 1 and Round 2 samples were analyzed with methods that did not provide a minimum detectable activity (MDA) that was below the RI screening criteria. Therefore, additional sampling was necessary to acquire definitive data.

Round 3 and Round 4 sampling events were performed with samples analyzed by different methods to achieve lower MDAs. Round 4 included the sampling of a then-recently installed upgradient well. Ra-226 and Th-232 were not detected above the RI screening criteria in Round 3 and Round 4. The data and these observations suggest the groundwater at the WACC site is not impacted above the screening criteria.

Chlorinated volatile organic compounds (CVOCs), including tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE), exceeded screening criteria in the groundwater at each of the six monitoring wells including an upgradient well. The RI concluded that CVOCs in groundwater at the site are likely from an upgradient source.

ES.4.6 Gamma Exposure Rate Surveys

Gamma exposure rate surveys confirmed the results from the previous gamma exposure rate surveys conducted within the WACC buildings, on sidewalks, and on the streets near the WACC property. Exposure rates remain above background levels throughout each of these areas, but were within the background range outside of a few blocks from the WACC property. The maximum gamma exposure rates observed were collected on Irving Avenue south of the WACC property at 220 (micro Roentgen per hour) μR/hr near the sidewalk curb and 338 μR/hr in the middle of the street. These readings were taken at waist height or approximately three feet above the ground surface.

The gamma exposure rates collected from within the school and daycare were all within or below the background observed for the neighborhood.

ES.5 Conceptual Site Model

The conceptual site model (CSM) follows the movement of the primary radionuclides from the monazite sands processing to the site media, including the building structures, soils, sewers, air, and groundwater. **Figure 1-8** presents an illustration of the CSM.

<u>Sources of Radionuclide Contamination</u>

The sources of radionuclide contamination are the monazite sands and the monazite sands processing byproducts (process liquors and waste tailings). Byproducts of the production process, including process liquors and process tailings, contained high concentrations of radionuclides. The former storage yards were likely used to stockpile and dispose of these tailings; the tailings were also used to fill low areas in and around the WACC property.

<u>Pathways for Contaminant Release/Transport</u>

Soil contamination resulting from process liquor disposal – Soil contamination around and below the sewer connection below buildings on Lots 42 and 44 is likely attributable to process liquor exfiltration via leaky drains and sewer pipes, and material handling within or adjacent to the kiln/vat building. Once the process liquor entered the soil matrix, it traveled downward through the soil column.

Sewer contamination resulting from process liquor disposal – Upon entering the CSS, the process liquors were diluted with incoming sewer water from other sewer branches. The radionuclides formed relatively immobile and low-solubility precipitates or compounds, traveling with the sediment downstream in the sewers or accumulating within the sewers as sludge or sediment within the sewer structures. Radionuclides also absorbed to the construction materials, staying in the matrix of the construction materials. Additionally, in areas of compromised integrity, radionuclides potentially migrated through leaks in the pipeline.

Soil contamination resulting from stockpiling, handling, and filling – Monazite sands were unloaded from the rail spur and stockpiled in the former storage yards along with the process tailings. Handling of the sands and tailings likely spread them throughout the soil surface of the yard and rail spur areas. Surficial runoff likely transported the sands and waste tailings from localized areas in the storage yards to downgradient areas near the property including the former rail spur, the Moffat Street and Irving Avenue intersection, and 338-340 and 350 Moffat Street. Additionally, transport of radionuclide-laden dust and particulates from the uncovered stockpiles in the air likely contributed to the surficial soil contamination found in the adjacent properties.

Contamination at depth below the Irving Avenue/Moffat Street intersection, Irving Avenue, and Moffat Street, potentially migrated from the WACC property by being utilized as fill during either road construction or sewer construction.

<u>Human and ecological receptors</u>

Human receptors may be exposed to the radionuclides through the following: direct contact with contaminated building materials, contaminated soils, waste tailings, and contaminated sewer materials; external radiation in areas of high radiation emanating from the previously mentioned contaminated materials; and, inhalation of radon- and thoron-contaminated air.

Th-232 was detected in sediment at the Newtown Creek outfall below biota concentration guides/no further actions levels developed as part of the ecological screening evaluation.

ES.6 Risk Assessments

A site-specific human health risk assessment (HHRA) (CDM Smith 2017b) and screening level ecological assessment (SLERA) (CDM Smith 2017c) were completed as part of the RI.

ES.6.1 Human Health Risk Assessment

Risks and hazards for all receptors are estimated using reasonable maximum exposure (RME) assumptions. Risks due to exposure to non-radioactive chemicals of potential concern (COPCs) are also estimated using central tendency (CT) assumptions when the RME assumptions result in risk estimates above EPA's thresholds. Radiological risk to all receptors was assessed using RESRAD Onsite Model Version 7.2, a model developed and maintained by Argonne National Laboratory. The online EPA PRG Calculator for Radionuclides was also used to evaluate radiological risk for scenarios with the highest risk for comparison purposes. Estimated risks are summarized below.

Current Receptors Chemical Risk

Due to the developed nature of the site, direct exposure to chemicals of potential concern (COPCs) in soil is limited for current receptors. In addition, groundwater is not currently used for any purpose at or near the site; therefore, direct exposure to contaminants in groundwater was not evaluated for current receptors.

Current Receptors Radiation Risk

Complete exposure pathways for current receptors to radionuclide of potential concern (ROPCs) include external radiation from soil, external radiation from outdoor and indoor surfaces, and inhalation of radon and thoron in indoor air. Cancer risks were estimated initially using RESRAD to screen risk across multiple pathways and time-frames. Subsequently, the EPA's PRG calculator was used to provide risk managers with risk estimates for important exposure scenarios (current and future workers, future residents). Non-radon-related cancer risk for commercial indoor workers and industrial workers exceeds EPA's target cancer risk range, primarily due to external exposure to Th-232 (over 90 percent), with the majority of the remaining fraction associated with Ra-226. Inhalation of dust particles and soil ingestion pathways make negligible contribution to risk. Cancer risk due to exposure to radon was estimated to be significantly higher than exposure to external gamma radiation. Exposure to thoron was estimated to be about two orders of magnitude lower than exposure to radon and was in the 1×10^{-5} range. EPA installed shielding in most of the work areas and radon mitigation systems in some areas on the WACC property in 2013. Shielding was effective in reducing annual exposure to current workers.

Future Receptors Chemical Risk

Cancer risk exceeds EPA's target threshold for future residents and is at the upper end of EPA's target range for industrial workers. The primary COPC cancer risk drivers are Aroclor 1260 and benzo(a) pyrene in surface soil. Hot spots for these COPCs are present on the WACC property.

Noncancer health hazards associated with exposure to surface soil for future residents exceed the target threshold due to exposure to Aroclor 1260 and selenium. Noncancer health hazards associated with exposure to surface soil for future industrial workers also exceed the target threshold.

Cancer risk for future construction/utility workers exposed to COPCs in surface/subsurface soil is within EPA's target range of 1×10^{-6} to 1×10^{-4}. Noncancer health hazards associated with exposure to surface/subsurface soil for future construction/utility workers exceed the target threshold due to exposure to Aroclor 1260.

Future Receptors Radionuclide Risk

The total cancer risk estimate for all exposure pathways is 2×10^{-2}. About half of this risk is associated with consumption of home grown produce, Radon inhalation accounts for about one-third of this risk, and external exposure accounts for slightly less than one quarter of this risk.

Total cancer risk for future on-property residents, excluding radon and the consumption of home grown produce hover around 5×10^{-3} throughout the 1,000-year period evaluated. Cancer risk when radon and consumption of home grown produce is excluded, was dominated by external exposure, which accounts for 80 to 90 percent of estimated risk. Th-232 was responsible for most (greater than 90 percent) of the risk due to external exposure. Radon alone may present risks similar to risks from external exposure. Risk reduction measures for Th-232 and Ra-222 are different and separate risk estimates for these two pathways facilitate estimates for risk reduction in alternative analyses.

Risks for both future indoor and industrial workers are anticipated to be much the same as risks for current workers. Any future commercial or industrial construction is likely to have a substantial on-slab foundation, which should provide much the same shielding as the shielding previously put in place. Total cancer risk for future workers considering shielding from a foundation and, excluding radon, ranged to 3×10^{-3} and to 4×10^{-3}. Cancer risks for future workers assuming no cover of the contaminated zone range may be as high as 5×10^{-3}.

Future development of the site would require construction workers to be onsite without benefit of shielding on a full-time basis. Cancer risk for construction workers would be about 5×10^{-5}. For utility workers exposed to sewer sediment, cancer risk would be about 2×10^{-4}.

Future risks for the general public and for offsite receptors are assumed to be similar to current risks for these receptors. High risk estimates (above 1×10^{-4}) for workers suggest some potential for the general public to experience exposure above regulatory thresholds.

ES.6.2 Screening Level Ecological Risk Assessment Summary

The site is in an industrial area with no environmentally sensitive areas (e.g., wetlands) and only limited habitat for most types of ecological receptors; thus, adverse exposures for ecological receptors at the site are unlikely. The evaluation focused on risks to ecological receptors exposed to the site-related combined sewer overflow (CSO) discharges in Newtown Creek (approximately 1.9 miles to the northwest). Newtown Creek is a tidal arm of the New York-New Jersey Harbor Estuary.

Maximum and mean radionuclide concentrations measured in sediment were compared to biota concentration guides (BCGs) for riparian animals in the aquatic ecosystem. The results of the screening evaluation verify that radionuclide concentrations in sediment in the East Branch of Newtown Creek are significantly less than BCGs and that dose to receptors is below biota dose limits.

ES.7 Media and Contaminants of Concern to be Addressed

Media of concern include the WACC building materials, soils underlying the WACC buildings, and surficial and subsurface soils extending beyond the WACC buildings. Additional media of concern include sediments/sludge and the sewer pipes and manhole materials within the CSS near the WACC property. In addition, indoor air is included as a media of concern for the purpose of developing RAOs and remediation alternatives for soils and building materials that also consider potential exposure via indoor air.

Remedial alternatives were developed to address the media and contaminants of concern (COCs) for this site:

- Soils/solids (including building material, sewer pipe, sediment in sewers)
  - Chemicals (soils only): benzo(a)pyrene and Aroclor 1260
  - Radionuclides: Th-232 and Ra-226
- Air (indoor): Radon and Thoron

ES.8 Remedial Action Objectives

The following remedial action objectives (RAOs) have been proposed to mitigate the potential present and/or future risks associated with exposure to contamination in the site buildings and soils.

- WACC and other impacted buildings
  - Reduce or eliminate human exposure via inhalation of radon and thoron, incidental ingestion, dermal adsorption, and external exposure to radiological contamination (Ra-226 and Th-232) present within the building to levels protective of current and anticipated future use by preventing exposure to contaminant levels above PRGs.
- Soils/solids (solids include sewer pipe, sediments/sludge in sewer and site material at off-property locations)
  - Reduce or eliminate the human exposure threat via inhalation, incidental ingestion, dermal adsorption, and external exposure to contaminated site soils and solids to levels protective of current and anticipated future land use by preventing exposure to benzo(a)pyrene, Aroclor-1260, Ra-226 and Th-232 to concentrations above PRGs.
  - Prevent/minimize the migration of site contaminants offsite through surface runoff, dust particulate migration, and CSS discharge.

ES.9 Preliminary Remedial Goals

For the WACC site, identification of preliminary remedial goals (PRGs) for the risk drivers included a consideration of background values, risk-based concentrations and applicable or relevant and appropriate requirement (ARARs) and to be considered information. PRGs for Ra-226 and Th-232 were calculated using the EPA PRG calculator to be consistent with EPA policy and to reflect likely future Site conditions. The PRGs for the COCs to be addressed in the FS are presented in **Table 2-4** and are summarized below:

Contaminants of Concern	Preliminary Remediation Goal
Soil/Solids:	
Aroclor 1260	1 ppm
Benzo(a)pyrene	1 ppm
Radium-226	1 p/Ci/g [1]
Thorium-232	4 pCi/g [1]
Indoor Air:	
Radon + Thoron	4 pCi/L

[1] The soil/solid radionuclide PRGs are based on criteria established using EPA PRG Calculator, which are derived for the concentration of a radionuclide above its naturally occurring background concentration. The listed criteria are to be added to the background value identified for the site to establish the PRG.

Figure 2-1 shows the aerial extent of soils exceeding the PRGs and the depth to which soils exceed the PRGs in site borings. **Figure 2-2** shows the portion of the sewer line exceeding PRGs.

ES.10 Development of Remedial Action Alternatives

A full range of remedial technologies and process options that have the potential to remediate the site COCs were evaluated using effectiveness, implementability, and cost as evaluation criteria. The technologies that passed the evaluation were combined into a range of remedial action alternatives. The following remedial action alternatives were assembled:

- Alternative 1 – No Further Action
- Alternative 2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

  This alternative consists of the following major components:

  - Temporary relocation of tenants in Lots 42, 44, and 46
  - Demolition of the warehouse building on Lot 33
  - Excavation of shallow contaminated soils exceeding the PRGs to a maximum depth of 4 feet
  - Excavation of contaminated sewer pipe and contaminated soil around sewer pipe from Manhole I-1 on Irving Avenue southwest of the WACC property and extending northwest to Manhole I-4 and sewer line jet cleaning of remaining portion of sewer pipe from Manhole I-4 to the Irving Avenue and Halsey Street intersection, and ending at the Halsey Street and Wyckoff Avenue intersection

- Final status survey (gamma scan and confirmation samples)
- Disposal of building debris, excavated soils, sewer pipe and sediment in a permitted landfill for radioactive waste
- Site restoration
- Installation of shielding (within buildings on Lots 42, 44 and 46)
- Maintenance of the radon mitigation system in building in Lot 42 and conduct radon monitoring in all buildings after excavation and backfill
- Institutional controls (e.g., environmental easement)
- Long-term monitoring
- Conduct five-year reviews

- Alternative 3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

  This alternative consists of the following components:

  - Permanent relocation of tenants in WACC buildings
  - Demolition of buildings on Lots 33, 42, 44, 46, and 48
  - Excavation of shallow contaminated soils exceeding the PRGs to a maximum depth of 4 feet
  - Excavation of contaminated sewer pipe and sewer line jet cleaning as described for Alternative 2
  - Final status survey (gamma scan and confirmation samples)
  - Disposal of building debris, excavated soil, sewer pipe, and sediment in a permitted landfill for radioactive waste
  - Site restoration
  - Institutional controls (e.g., environmental easement)
  - Long-term monitoring

- Alternative 4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal

  This alternative consists of the following components:

  - Permanent relocation of tenants in WACC buildings
  - Demolition of all WACC property buildings
  - Excavation of all soils exceeding PRGs
  - Excavation of contaminated sewer pipe and sewer line jet cleaning as described for Alternative 2
  - Final status survey (gamma scan and confirmation samples)
  - Disposal of building debris, excavated soil, sewer pipe, and sediment in a permitted landfill for radioactive wastes
  - Site restoration

ES.11 Detailed and Comparative Analysis of Remedial Action Alternatives

EPA's nine evaluation criteria address statutory requirements and considerations for remedial actions in accordance with the NCP and additional technical and policy considerations proven to be important for selecting among remedial alternatives (EPA 1988). The remedial alternatives underwent comparative analyses using the two threshold criteria of overall protection of human health and the environment and compliance with ARARs and the five balancing criteria of long-term effectiveness and permanence, reduction of toxicity/mobility/volume through treatment, short-term effectiveness, implementability, and cost. Assessment of the modifying criteria, State acceptance and community acceptance, will be completed after comments on the FS and proposed plan have been received by EPA and are addressed in the Record of Decision (ROD).

ES.11.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold criterion that must be met. Alternative 4 would achieve RAOs and protection of human health and the environment by removing contaminated soil, CSS, and building materials above the PRGs from the site. The residual risks would be within EPA's acceptable risk range. Alternatives 2 and 3 also would achieve RAOs and protection of human health by excavation and off-site disposal of contaminated surface soil and backfill with clean fill in combination with long-term management and institutional controls. Alternative 1 would not be protective of human health and the environment as the contaminated soil and buildings would remain unchanged.

ES.11.2 Compliance with ARARs

Compliance with ARARs is a threshold criterion that must be met. Because no action would be taken under Alternative 1, the presence of unaddressed contaminated soil would not meet chemical-specific ARARs. Alternatives 2, 3 and 4 would meet the chemical-specific ARARs. Alternative 2 would meet the ARARs with a combination of removal and offsite disposal of surface contaminated soils, building, and CSS debris; placement of shielding over contaminated soils under WACC buildings that would remain in place; and the use of radon mitigation systems in impacted buildings. Alternative 3 would meet the ARARs with a combination of removal and offsite disposal of shallow contaminated soils, building, and CSS debris; placement of a soil cover over contaminated soils that remain in place; long-term maintenance of the soil cover, and implementation of institutional controls (ICs) to protect the integrity of the soil cover and require the use of radon mitigation systems if buildings are constructed on the WACC site in the future. Alternative 4 would meet the ARARs through removal and offsite disposal of contaminated soils, building, and CSS debris.

Site activities for Alternatives 2 through 4 would be designed to meet location- and action-specific ARARs.

ES.11.3 Long-Term Effectiveness and Permanence

Alternative 4 would provide the highest degree of long-term protectiveness and permanence because contaminated building materials and CSS debris and contaminated soils above the PRGs would be removed from the site. Alternative 2 would provide long-term effectiveness and permanence for the buildings that would remain in place. Long-term effectiveness and permanence would rely on the maintenance of the soil covering the contamination left in place and implementation of ICs to require the use of radon mitigation systems if buildings are constructed on the former WACC property in the future. Alternative 3 would provide a slightly greater degree of long-term effectiveness and permanence than Alternative 2 in that it would leave no WACC buildings in place and would employ shallow excavation and backfill with clean fill in the excavation areas; however, it would still require ICs to limit intrusive activity and allow access for monitoring In a highly urban urea that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities. Long-term effectiveness and permanence for both Alternatives 2 and 3 would be dependent on adherence to controls by a range of entities, some of which likely have minimal or no experience in managing exposures or waste materials identified at this Site. Because the radioactive half-life of Th-232 is 14 billion years, the ICs would need to be managed in perpetuity. Ensuring such controls remain effectively in place can be difficult. Alternative 1 would provide no long-term effectiveness and permanence because no action would be taken. Risks from the site contaminants would remain the same.

ES.11.4 Reduction of Toxicity, Mobility or Volume through Treatment

Because no action would be taken, Alternative 1 would not address this criterion. Alternatives 2 through 4 would not meet the statutory preference for treatment as a principal element of the remedial action. However, no proven and cost-effective treatment technology is currently available to treat radioactive wastes.

ES.11.5 Short-Term Effectiveness

Alternative 1 would not have any impacts to the community and workers because no action would be taken. Alternatives 2 through 4 all would require heavy construction activities that could potentially impact the community, however, employing appropriate health and safety protocols and exercising sound engineering practices would protect the community. Planning for short-term impacts caused by heavy constructions activities, such as street closures and disruption to utility services would need to be implemented to minimize impact to local businesses and residents to the extent possible. Additional impacts include the need to permanently relocate several businesses under Alternatives 3 and 4, and temporarily relocate them during remediation under Alternative 2.

Alternative 4 would require the largest amount of space to effectively carry out all components of the alternative (i.e., building demolition, excavation, staging, CSS removal and replacement, and backfill operations) because it involves the largest amount of demolition and excavation. As a result, Alternative 4 would likely cause the greatest level of short-term risk to the community and potential impact to workers due to the need to safely manage and conduct these operations in limited space and constrained areas. Alternatives 2 through 4 all would involve heavy construction activities that would require implementation of dust control measures, stormwater run-on and runoff control, and measures to mitigate noise impact on the community. In addition, air monitoring would be required to reduce risks to workers and the community from fugitive emissions during construction and remediation. Potential risk to remediation workers associated with direct exposure to contaminated material would be mitigated through the use of PPE and standard ALARA principles. Alternative 3 is similar to Alternative 4 but would cause somewhat less short-term risk to the community and potential impact to workers because less soil would be excavated from under the demolished buildings on the WACC site. Under Alternative 2, only the warehouse on Lot 33 would be demolished, and would involve only shallow excavation; therefore, there would be less impact to the community and workers due to demolition and excavation.

Finally, Alternatives 2 through 4 all require the off-site transport of contaminated soil and on-site transport of clean backfill, which may pose an increased risk for traffic accidents which in turn could result in the release of hazardous substances. However, a traffic control plan would be developed to mitigate adverse impacts to traffic. The number of truckloads of excavated material to be transported offsite range from approximately 1,400 truckloads for Alternative 2 to 1,900 truckloads for Alternative 4.

The durations estimated for the alternatives to achieve protection and RAOs are:

Alternative 1: would not achieve RAOs

Alternative 2: approximately 1 year and 3 months

Alternative 3: approximately 1 year and 4 months

Alternative 4: approximately 1 year and 5 months

These durations are estimated and based on construction activity production rates. Actual durations may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

ES.11.6 Implementability

Alternative 1 would be the easiest to implement since it involves no action. The remaining alternatives, to varying degrees, all would have implementability issues related to excavation work. This is due in part not only to the nature of the activities that would be conducted for each alternative, but also because those activities would be implemented in an urban setting with many physical constraints that present significant implementation challenges.

Although the total volume of material to be excavated under Alternative 2 is less than the other alternatives, the targeted demolition and excavation of Lot 33, coupled with the placement of shielding in the other WACC site buildings, would likely make Alternative 2 more difficult to implement. This is due to the structural condition of the buildings on the lots adjacent to Lot 33 and the physical constraints present in the area. The demolition of all the WACC buildings that would occur under Alternatives 3 and 4 would make the demolition and excavation components of those alternatives easier to implement than the demolition component of Alternative 2. Excavation work and ICs for Alternatives 2 and 3 would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, some of which may have minimal or no experience in managing exposures or waste materials of the type identified at the Site. Because of the long radioactive half-life of Th-232, the ICs for Alternatives 2 and 3 would need to be managed in perpetuity. Conversely, Alternatives 2-4 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials under these alternatives and the implementation of institutional controls needed for Alternatives 2 and 3 would be relatively easy to implement. Alternatives 2 through 4 all would be administratively feasible; although, all three alternatives would require significant administrative coordination efforts.

ES.11.7 Cost

Detailed cost estimates presented in **Appendix D** are expected to have an accuracy range of –30 percent to +50 percent (EPA 2000). The detailed analysis level accuracy range of –30 percent to +50 percent means that, for an estimate of $100,000, the actual cost of an alternative is expected to be between $70,000 and $150,000 (EPA 2000). A comparison of alternative costs is presented below.

Alternative	Estimated Capital Costs[1]	Total O&M Cost[2]	Total Present Worth
1 – No Further Action	$0	$0	$0
2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs	$34.4M	$1.4M	$36.2M
3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs	$33.5M	$745,000	$34.2
4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal	$39.4M	$0	$39.4M

[1] Capital costs include contingency.

[2] Discount factor is calculated using an interest rate of 7% applied over the duration of O&M and long-term monitoring for the alternative. O&M duration for Alternative 1 and Alternative 4 is zero years. In accordance with EPA guidance, the O&M and long-term monitoring cost for Alternative 2 and 3 is estimated using a duration of 30 years.

Section 1

Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment 054-RICO-A282 under the U.S. Environmental Protection Agency (EPA), Remediation Action Contract 2 (RAC 2) to complete a remedial investigation/feasibility study (RI/FS) for the Wolff-Alport Chemical Company (WACC) Superfund Site (the site) located in Ridgewood, Queens, New York. The lead agency for the site is EPA Region 2.

1.1 Purpose and Organization of the Report

The purpose of the feasibility study (FS) is to identify, develop, screen, and evaluate a range of remedial alternatives for the contaminated media and provide the regulatory agencies with sufficient information to select a feasible and cost-effective remedial alternative that protects public health and the environment from potential risks at the site. This FS report is comprised of five sections as described below.

- **Section 1 – Introduction** provides a summary of the remedial investigation (RI), including study area description, history, and physical characteristics; RI sampling results; nature and extent of contamination; conceptual site model (CSM); and human health and ecological risks.

- **Section 2 – Development of Remedial Action Objectives and Technology Screening** develops a list of remedial action objectives (RAOs) by considering the characteristics of contaminants, the risk assessments, and compliance with applicable or relevant and appropriate requirements (ARARs). Section 2 also documents the quantities of contaminated media, identifies general response actions (GRAs), and identifies and screens remedial technologies and process options.

- **Section 3 – Development of Remedial Action Alternatives** presents the remedial alternatives developed by combining the retained technologies and process options.

- **Section 4 – Detailed Analysis of Remedial Action Alternatives** provides conceptual design assumptions for the alternatives. This section also provides a detailed analysis of each alternative with respect to the following seven criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume (T/M/V) through treatment; short-term effectiveness; implementability; and cost. Two additional criteria – state acceptance and community acceptance – are not evaluated in this FS. Assessment of state and community concerns will be completed after comments on the FS and proposed plan have been received by EPA and are addressed in the Record of Decision (ROD). This section also provides an overall comparative analysis of the remedial alternatives.

- **Section 5 – References** provides a list of reference used to prepare the FS.

1.2 Site Description

The WACC site is in Ridgewood, Queens County, New York, at the county border with Brooklyn (**Figure 1-1**). The site includes the former WACC property that is now subdivided into several properties of Block 3725, as well as adjacent areas including streets, sidewalks, buildings, and the sewer system where contaminants have migrated or have the potential to migrate from the WACC property.

What is hereafter referred to as the WACC property is the triangular property situated on Lots 31 (partial), 33, 42, 44, 46, and 48 (**Figure 1-2**). The WACC property covers approximately 0.75 acre bounded by Irving Avenue to the southwest, Cooper Avenue to the northwest, and an active cabinet manufacturer (5606 Cooper Avenue) to the east. At present, the property is covered with contiguous structures, except along its eastern edge in the former rail spur area. These structures will be referred to as the WACC buildings. A description of the various lots that make up the WACC property and the buildings that occupy each are included in the table below.

Lot	Address	Description
31	NA	The former rail spur adjacent to the WACC buildings is fenced, covered with gravel and used as an automobile storage/parking area by Primo Auto Body. The non-fenced portion of the former rail spur, which is not adjacent to the WACC buildings, is partially vegetated.
33	1133-1139 Irving Avenue	A 1-story masonry warehouse formerly owned by Arctic Glacier Losquardo, Inc. The property was recently transferred to Irving Unique Development, LLC and is currently unoccupied.
42	1129 Irving Avenue	A 1-story masonry building, subdivided and occupied by TerraNova Construction and Primo Auto Body. The TerraNova building is primarily used for construction but also has an office that is frequently occupied. The building housing the Primo Auto Body shop is active, with 5-10 employees typically occupying the building during the work day.
44	1127 Irving Avenue	A 1-story masonry building housing the Celtic Bike Shop. The building is active, with 2-5 employees typically occupying the building during the work day. This building was previously occupied by Primo Auto Body.
46	1125 Irving Avenue	A 2-story masonry and frame building housing the Jarabacoa delicatessen/grocery, office space, and three unoccupied residential apartments on the second floor. Typically, there are 2-5 employees occupying the building during the work day. A second attached one-story masonry building houses Primo Flat Fix and a former mini-all terrain vehicle shop.
48	1514 Cooper Avenue	A 1-story masonry building housing the K&M Auto Repair shop and office space. The building is actively used, with 2-5 employees typically occupying the building during the work day.

The neighborhoods surrounding the WACC property contain light industry, commercial businesses, residences, a school, and a daycare. An active rail line passes within 125 feet to the southeast of the property; the Cemetery of the Evergreens is located to the east and south of the rail line and covers over 225 acres (**Figure 1-1**). The sidewalk and street along Irving Avenue adjacent to the WACC buildings typically contain many vehicles being serviced by the local businesses. The intersection of Irving Avenue and Moffat Street (i.e., the southern corner of the WACC property) is an active area for trailer parking and unloading. There is other occupied housing is present near the WACC property on Cooper and Irving Avenues and Moffat Street.

Most of the area south and west of the WACC property is densely populated and contains multi-family homes and apartments.

As part of the RI, the properties listed below were investigated (or reviewed) to determine if they have been impacted by WACC processes. These are in the neighborhood of the WACC property, and include residential, commercial, and school properties (see **Figure 1-2)**.

308 Cooper Street – Former residences across Irving Avenue from the WACC property. The building was recently demolished in 2007 and the property is under remediation due to soil contamination found by the property owner's consultant. The property is zoned residential and the owner likely plans to redevelop the property. The former residential structures were in place since at least 1914.

5606 Cooper Avenue – This currently active cabinet manufacturer forms the northeast boundary of the WACC property. The property contains a portion of the former rail spur and a large manufacturing building. The building was constructed sometime between 1954 and 1966.

335 Moffat Street – This former ice warehouse building recently became unoccupied. It was built sometime between 1933 and 1951.

338-348 and 350 Moffat Street – The former warehouses at 338-348 Moffat Street are now used for residential purposes. An adjacent building at 350 Moffat Street houses a circus training facility where families with children often spend the day. These structures appear to have been constructed between 1954 and 1966.

School– The Frances E. Carter (K384) public elementary and intermediate school (P.S./I.S.) is located within ¼ mile southwest of the WACC property on Kings County Tract 409, Block 2002, at 242 Cooper Street. The building appears to have been constructed between 1966 and 1975. Previously the area was filled with residential structures.

Daycare – The Audrey Johnson Daycare is located within ¼ mile south of the WACC property at 272 Moffat Street. The building structure appears to have been in place before 1924.

1.3 Site History

WACC operated at the property from the 1920s until 1954, importing monazite sand via rail and extracting rare earth metals from the material. Monazite sand contains approximately 6 percent (%) to 8% or more of thorium and 0.1% to 0.3% of uranium. The acid treatment process of the monazite sands converts the phosphate and metal component of the monazite to aqueous species, rendering the rare-earth materials extractable and dissolving the Th and U in a sulfuric acid waste process liquor and generating tailings. This process concentrated the thorium-232 (Th-232) and uranium-238 (U-238) in the process liquor, with Th-232 at higher concentrations. Additionally, the process tailings would have remnant amounts of Th-232 and U-238.

Until 1947, WACC disposed of the waste from monazite sand processing in the sewer (process liquors) and possibly by burial/spreading on the property (waste tailings). During its years of operation, WACC occupied three structures under the address of 1127 Irving Avenue (currently lots 42 and 44). As shown on **Figure 1-3**, the WACC operation included two yard areas: one between the company's buildings at Lot 42 and the other on the eastern end of the property at the northern end of Moffat Street at Lot 33. These former yard areas were reportedly used as staging areas for monazite sands or waste tailings. WACC did not operate at Lot 46 or Lot 48, but those properties are affected by the radioactive materials associated with the site.

According to the U.S. Department of Energy (DOE), the Atomic Energy Commission (AEC) ordered WACC to halt sewer disposal of Th waste in the fall of 1947 (Louis Berger & Associates [LBA] 2010). Thereafter, thorium was precipitated as thorium-oxalate sludge and sold to the AEC.

1.4 Radiological Properties of Site Radionuclides

1.4.1 Materials and Processes

Monazite sand contains, by weight per cent, approximately 6% to 8% of thorium and 0.1% to 0.3% of uranium. The Th-232 and U-238 are categorized as decay chain radionuclides and as such their presence is accompanied by the decay progeny which in turn are also radioactive. **Figure 1-4** illustrates the decay chain and components for Th-232 and U-238.

1.4.2 Decay Chain and Equilibrium

In the natural state, i.e. no chemical or physically invasive processes, the decay chain radionuclides are in what is termed “secular equilibrium”, meaning that for each decay of a parent, there is a corresponding decay of the progeny such that the activity levels of the parent and progeny are approximately equal. Certain processes such as soil disturbance or chemical separation can disrupt this equilibrium resulting in unequal concentrations of the parent and the progeny.

Secular equilibrium thus allows one to estimate the concentration of one radionuclide by knowing the concentration of any other radionuclide in the decay chain. For example, in the Th-232 decay chain, actinium-228 (Ac-228) is often measured using gamma spectroscopy while Th-232 can only be measured by more elaborate radiochemistry analysis. By ascertaining the level of Ac-228 in a sample one also has a measure of Th-232. Because of this feature, the field remedial investigation work employed an onsite gamma spectroscopy system to aid in rapid identification of sampler radionuclides and concentrations. In this case, the Th-232 was estimated by identifying Ac-228, progeny within the Th-232 decay chain, and the Ra-226 was estimated by identifying bismuth-214, progeny within the U-238 decay chain.

There are two gaseous components of each decay chain, Radon-220 (also known as thoron) from the Th-232 chain and Radon-222 (Rn-222) (also known as radon) for the U-238 decay chain. Both thoron and radon are inert gasses and as such their principal transport mechanism through soil is via diffusion and unrelated to the chemical composition of the medium. When radon diffuses through the ground to the surface, differential pressures between soil and the overlying structure or open air enhance or impede the radon flow depending on whether the differential is positive or negative. Building characteristics such as a high ventilation exhaust rate may induce a significant negative differential pressure and thus increase the flow of radon into the building.

Because of these properties, radon and thoron may enter buildings through building cracks, drains or other penetrations and become a potential source of exposure to the occupants. The radiological dose to the lungs received from exposure to thoron and radon is due to the particulate short-lived progeny of the radon gas. The level or concentration of thoron and radon progeny is dependent on the concentration of thoron and radon entering the space and speed (or exchange rate) of the gas with the building air intake system. Buildings with high levels of radon and a low exchange rates tend to result in a greater level of progeny build-up and thus a higher radiological dose and corresponding risk than buildings where radon entrance is limited or radon is removed from the building at a rate that limits progeny build-up.

Radiological doses from radon and thoron occurring in outside environments tend to be significantly less than those indoors because the natural convective forces both remove the radon before progeny build-up occurs and also dilutes the level of radon present. In addition, thoron, due to its extremely short half-life of 55 seconds compared to Rn-222's half-life of 3.8 days, tends to produce lower concentrations in work/building spaces because of decay during transport from the media below the building or work space. As such, thoron is seldom a concern for health risk.

1.4.3 Principal Radioactive Decay Emissions

The process of radiological decay usually involves nuclear transitions that release energy in the form of waves (gamma rays) or particles (alpha or beta). For the decay chains discussed previously all three forms of energy emissions will be present at the site. The gamma ray emissions can be used in field work to identify the locations of contaminants that exceed typical background radiation levels and identify the nuclide and concentration present.

The alpha and beta emissions are often used to quantify the level of contamination present on a surface of a floor, wall, or piece of equipment. The purpose of measuring surface contaminants is to obtain an estimate of the potential for re-suspending radioactive materials into the surrounding atmosphere with potential for inhalation of ingestion of those particles. EPA's "Radiation: Facts, Risks, and Realities" (EPA 2012a) provides a more detailed discussion of radioactive decay, radiation emissions and their interactive mechanisms.

1.4.4 Radiological Units

Through-out this document the measure of potential biological damage from exposure to radiation or radiological dose will be referred to using the term millirem (milli Roentgen equivalent man). To provide perspective, the amount of dose one receives from background radiation in the United States varies between 200 to 300 millirem per year. In this report, exposure rates will be expressed as micro roentgens per hour (μR/hr). A rough rule of thumb is one-thousand micro roentgens per hour will be equivalent to one millirem per hour.

The amount of activity in the report will be expressed in picocuries (pCi) or disintegrations per minute (dpm). Those terms provide an expression of how many radioactive decays are occurring per unit of time from soil, water or surface. The equivalent of 2.2 dpm is 1 pCi. Soils in New York State have background concentrations of Th-232 that range from 0.5 to 2 pCi/gram (pCi/g) (Duval et. al., 2005) (ORNL/TM-7343).

Monitoring instrumentation, except for the type measuring exposure rates, provides measurements in units of counts per minute (cpm). CPM values provide a qualitative indication of the presence of elevated levels of radioactivity when compared against naturally occurring background count rates. Count rates can be converted to pCi or dpm per mass/volume/area units when detection efficiencies are known for the measurement situation. In most cases, such as use of sodium iodide detectors to acquire gross count rates for gamma emissions, a conversion to pCi is not made as it is more accurate to sample the impacted media and analyze by certified laboratory methods or, in the case of the remedial investigation, by a field gamma spectroscopy system.

1.5 Site Investigations

The following sections summarize both the historical field activities and the most recent remedial investigation performed at the site.

1.5.1 Previous Investigations

The following is a brief timeline of the investigation findings at the WACC site.

Initial scoping-level radiological surveys performed by the New York State Department of Environmental Conservation (NYSDEC), New York City Department of Mental Health and Hygiene, and EPA in 2007 found radiological impacts throughout the WACC property and the nearby sewer.

Follow-up investigations by the New York City (NYC) Department of Design and Construction (DDC) in 2009-2010 found waste tailings consisting of black or gray ash-like material in a contaminated soil layer beneath the WACC property buildings, sidewalks, and asphalt surfaces of Irving Avenue and Moffat Street, and in the surface soils of the former rail spur. Th-232 concentrations up to 1,133 pCi/g were reported from soil samples containing tailings. During the NYCDDC investigation at the WACC property, thoron and radon were detected in the deli basement at a concentration of 12.7 picocuries per liter (pCi/L) and 1.4 pCi/L, respectively.

In September 2012, EPA collected gamma radiation exposure rate measurements (in μR/hr) and thoron and radon concentration measurements on and around the perimeter of the source area and at background locations (Weston 2012). The gamma radiation exposure rate measurements identified hot spots along the former rail spur and in the sidewalks and streets adjacent to the former facility. The contaminated area (i.e., the source area), defined as the extent to which the gamma radiation exposure rates equal or exceed two times the site-specific background gamma radiation exposure rate, was identified as extending throughout most of the WACC property and in some of the adjacent street and sidewalk areas. Radon concentrations ranged from 0.34 pCi/L to 4.85 pCi/L. The radon measurements made in the 2012 survey indicated a background concentration of 0.15 pCi/L. Thoron concentrations ranged from 0.33 pCi/L to 366 pCi/L. The thoron measurements made in the 2012 survey indicated a background concentration of 0.10 pCi/L. With the exception of one sample, all thoron/radon measurements were collected six inches from the ground surface.

Investigations have also indicated that radiological residual contamination still exists in or around the sewer lines that were used by WACC. During periods of heavy flow such as rainstorms, combined sewer overflows (CSOs) discharge from this combined sewer system (CSS) to the East Branch of Newtown Creek west of the WACC property. In 2013, Bureau Veritas North America performed an investigation on behalf of the New York City Department of Environmental Protection to assess the current impact to the sewers in the vicinity and downgradient of the

WACC property. Soil borings were advanced on either side of the sewer pipeline. Soil boring results did not show contaminated soils along the sewer lines except those immediately adjacent to the WACC property. However, soil beneath the sewer line has not been investigated and is potentially contaminated. Gamma surveys in the sewer manholes were above background value at least as far downgradient as the intersection of Irving Avenue and Halsey Street (approximately ¼ mile from the WACC property).

Since October 2012, EPA has conducted additional monitoring and mitigation activities at the WACC property and adjacent areas. Surveys conducted in October and November 2012 confirmed elevated gamma radiation levels. In December 2012 and February 2013, radon and thoron monitoring in the WACC property buildings confirmed the elevated readings. In April 2013, EPA installed fencing at the site and shielded portions of the radioactive soil with rock and clean fill to reduce accessibility to the waste material. A radon mitigation system was also installed within one building. Additional shielding consisting of lead, steel, and concrete was installed within several structures at the WACC property and along a portion of the Irving Avenue sidewalk. These activities were completed in December 2013. Following placement of the shielding and the radon and thoron mitigation system, EPA conducted surveys at the WACC property that showed gamma exposure rates had been reduced by 69 to 94% and radon concentrations decreased by more than half.

EPA conducted a search for radon/thoron potential gas entry points in TerraNova (Lot 42), Primo Auto Body (Lot 42), Celtic Bike Shop (Lot 44), the Jarabacoa Deli (Lot 46), the school, and the daycare using a radon detector in SNIFF mode, sampling analysis performed in small increments of less than several minutes, which allows for quick qualitative surveys. No potential gas entry points were found in TerraNova (December 2012), the Primo Auto Body, the Celtic Bike Shop (December 2012), or the deli (February 2013). A single gas entry point was identified in the school basement with an air SNIFF average measurement of 17.9 pCi/L of radon and 24.4 pCi/L of thoron (December 2010-January 2011). A single gas entry point was identified in the daycare with an air SNIFF two-day average measurement of 0.6 pCi/L of radon and 2.06 pCi/L of thoron (December 2012). Following completion of these additional investigations and mitigation activities, the site was listed on the National Priorities List on May 12, 2014.

1.5.2 Remedial Investigation

CDM Smith performed the initial RI field investigation between September 18, 2015 and November 17, 2016 to address data gaps identified through review of previous investigations, in support of characterization of the nature and extent of contamination in building materials, soil, sewers and sewer sediments, creek sediments, groundwater, and air (CDM Smith 2017a). A supplemental investigation consisting of the installation of an upgradient monitoring well, soil boring and samplings at the school and daycare, and the collection of thoron measurements at the daycare was performed at the end of March 2017 with groundwater sampling completed in April 2017 (CDM Smith RI 2017a).

Environmental media investigated during the RI included soil, sediment, groundwater, air, and building/sewer construction materials. Samples were primarily collected to delineate the extent of media contaminated by radioactive waste; however, some samples were also analyzed for non-radiological contaminants. The major RI field activities are listed below.

- Building investigations, including building material gamma surveys and wipe and building materials sampling
- Soil investigations, including gamma walk-over surveys, downhole gamma logging, and soil sampling
- Hydrogeologic investigations, including monitoring well installation and gamma logging, groundwater sampling and synoptic water level measurements, and hydraulic conductivity assessments
- Sewer investigations, including fiberscope mapping with in-sewer gamma scan and gamma exposure rate surveys, sewer material sampling, sewer soil borings, and sediment sampling at the East Branch of Newtown Creek where the sewers discharge
- Gamma exposure rate confirmation surveys
- School and daycare investigations, including soil sampling, gamma exposure rate surveys, and radon and thoron evaluations

In addition to the collection of concrete core and wipe samples in the building, a buildings material survey was completed to determine the amount and type of hazardous materials present in the WACC property buildings to help determine costs of potential demolition and disposal.

A summary of the RI sample results is presented in the Section 1.6 discussion of the nature and extent of contamination.

1.6 Physical Setting

The following subsection presents the physical characteristics of the study area, including the topography and drainage, geology, and hydrogeology.

1.6.1 Topography and Drainage

The WACC property is at an elevation of approximately 70 feet above mean sea level (msl), and the ground surface in the area generally slopes gently to the southwest. The eastern edge of the site is adjacent to an elevated train line parallel to Moffat Street. The ground surface rises sharply toward the train line and continues to rise to the cemetery east of the site to elevations as high as 160 feet above msl. The cemetery areas are elevated as they are in glacial terminal moraine deposits. **Figure 1-5** presents a detailed topographic elevation contour map.

The site is in a highly urbanized area, where infiltration of precipitation is largely restricted due to the high percentage of ground surface covered by pavement and buildings. The large cemetery just east of the site is mostly unpaved and allows more infiltration of precipitation than surrounding areas. Storm water in the majority of the site area is directed into catch basins that connect to a CSS (shown on **Figure 1-5**). The WACC property is located at the head of a branch of the sewer system. The sewer flows away from the property to the west down Irving Avenue before turning on Halsey Street and joining larger sewers on Wyckoff Avenue. During large storms, these sewers discharge directly into the East Branch of Newtown Creek, which is approximately 1.9 miles from the WACC property.

1.6.2 Geology

The site is located along the western edge of Queens County, on the Brooklyn border. **Figure 1-6** presents geologic cross-sections based on the lithologic data collected during drilling at the site. Drilling advanced into the upper portion of the aquifer in this area and encountered two types of unconsolidated material: fill and Upper Glacial Aquifer deposits (till and outwash).

Fill

Fill near the WACC property is typically 5-15 feet thick and is generally characterized by the presence of man-made materials (brick, coal, various building materials) intermixed with silt, sands, and gravels. The distinction between fill and the underlying glacial material was difficult when man-made debris was not present in the soil. This is representative of regrading of native materials within the area.

Much of the upper layers of the fill in borings at the WACC property and in some borings to the south on Moffat Street was a black, gray, and/or white cinder or ash-like material. This material is likely waste tailings described in previous reports and was found between 0-4 feet below ground surface (bgs) near the WACC property and between 0-6 feet bgs along Moffat Street. This material corresponds well with intervals of elevated downhole gamma readings collected at the borings and was discussed further in Section 4 of this report.

Upper Glacial Aquifer Deposits

Soil borings at the site generally indicate the presence of Upper Glacial Aquifer soils extending from the bottom of fill (0-15 feet bgs) to beyond the deepest boring performed at the site (75 feet bgs). The upper portion of the glacial deposits (down to approximately 25-37 feet bgs) is made up of glacial till, which is yellowish brown dense silty sand and gravel. The material underlying the glacial till is glacial outwash, slightly more uniform and coarse in texture than the till and extends from the bottom of the till to at least 75 feet bgs (total depth of exploration at the site).

Based on ground surface topography and the top of geologic surface contour maps of the various units (discussed above) created by Soren (1978), the interpreted total thickness of the Upper Glacial Aquifer soils in the site area is about 170 feet. The Magothy Formation is absent at the site and the Upper Glacial Aquifer is underlain by the Gardiners Clay (approximately 50 feet thick), which is in turn underlain by the Raritan Clay (approximately 130 feet thick). The Lloyd aquifer is approximately 40 feet thick, and the bedrock surface is expected to be encountered at a depth of about 390 feet bgs, although some sources have estimated this depth to be closer to 450 feet bgs.

1.6.3 Hydrogeology

Depth to water at the site is about 60 feet bgs (12 feet amsl). Based on the geologic literature (Soren 1978), the base of the Upper Glacial Aquifer in this area is assumed to be the Gardiners Clay, which is present at elevation 100 feet below msl at the site, or about 170 feet bgs. The saturated thickness of the aquifer is estimated to be about 111-114 feet, based on the depth to water at each well. The monitoring well screens installed during the RI are 5-15 feet below the water table surface in partially penetrating wells in the unconfined aquifer.

The synoptic water level measurements collected on April 12, 2017 are provided on **Figure 1-7**. The gradient direction at the water table is generally to the south and the horizontal gradient is gentle, about 0.0006 feet per linear foot. This compares reasonably well to regional water level contours measured by United States Geological Survey in 2010**.**

The hydraulic conductivity of the upper 10 feet of the Upper Glacial Aquifer in this area was estimated to be about 30 feet/day by slug tests during the RI (CDM Smith 2017a). This is consistent with published values for fine to coarse sand, but is much lower than published values for the outwash deposits of the upper glacial aquifer, e.g., 270 feet/day (Soren 1971). Based upon the measured horizontal hydraulic gradient, the estimated hydraulic conductivity and an assumed porosity of 20%, the seepage velocity of the shallow groundwater is estimated to be 0.09 foot per day.

1.7 Nature and Extent of Contamination

The nature and extent of contamination in site media was assessed by comparing sample results to the screening criteria developed during the RI (CDM Smith 2017a). The nature and extent of contamination discussed below focuses on those radionuclides and chemicals that most frequently exceeded screening criteria and were not likely attributable to another source which included: radionuclides found in all media throughout the site, BAP in soil, and PCBs in soil. The RI screening criteria are presented in **Appendix A**.

The RI screening criteria for radionuclides are based on the 95% upper tolerance level (UTL) calculated from the soil background dataset. The 95% UTL for Th-232 and Ra-226 are 1.2 pCi/g and 0.92 pCi/g, respectively. Because no background samples were collected by CDM Smith for radon, thoron, or direct gamma exposure rates, other survey data sets were used to generate screening values. In the case of indoor radon, a New York State Department of Health (NYSDOH) data base (NYSDOH 2016) was used to establish 95% UTLs for a basement and a first-floor area at 1.2 pCi/L and 0.5 pCi/L, respectively. A perimeter survey study (Weston 2013) performed in 2013 was used to establish outdoor screening levels for radon and thoron and direct gamma exposure rates. The outdoor screening levels for radon and thoron are 0.1 pCi/L and 0.1 pCi/L. Because no indoor thoron background measurements were made, the outdoor values were used as screening levels for indoor thoron. This assignment biases the screening level to a conservative or lower level. For direct gamma exposure rates, the screening level was established at the upper end of the background range of exposure rate levels measured in the 2013 survey and is 13 µR/hr. Because of complex variance due to geometries and surrounding building/surface materials involved in exposure rate measurements, the use of a statistical UTL would create an overly conservative screening value with no commensurate benefit for identifying potentially impacted areas.

For chemical contaminants, the soil screening criterion for each chemical contaminant was the lowest of the EPA Regional Screening Levels (RSLs) for residential soils, NYSDEC Restricted Use Soil Cleanup Objectives, and NYSDEC Supplemental Soil Cleanup Objectives. The groundwater screening criterion for each chemical contaminant was the lowest of the Federal Maximum Contaminant Levels (MCLs), EPA RSLs for Tap Water (cancer risk = 1×10^{-6} [1 in 1 million]; noncancer hazard quotient = 0.1), and NYSDEC Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.

1.7.1 Building Materials

Gamma surveys to measure gamma radiation were performed inside the buildings at the WACC property, including Lot 33 (warehouse), Lot 42 (Terra Nova and Primo Auto Body), Lot 44 (Celtic Bike Shop), Lot 46 (Jarabacoa Deli and Primo Flat Fix), and Lot 48 (K&M Auto Repair) to obtain gamma radiation counts per minute for the building surfaces. The gamma count rates provide an indication of the presence of elevated areas of radioactivity. This survey method is useful in identifying locations likely to have contaminants embedded or on the surface of building materials. Locations to conduct additional alpha/beta measurements, wipe sampling, and building material core sampling were selected based on the results of the gamma surveys conducted throughout the WACC buildings. The alpha/beta results were compared to the acceptance criterion for Th-232 from Nuclear Regulatory Commission's (NRC's) Regulatory Guide 1.86 (1974) on decommissioning release limits, 1,000 dpm/square centimeter (cm^2), to determine what areas contained elevated alpha.

Direct alpha/beta measurements were greater than 1,000 dpm/cm^2 at three locations: Lot 46, along the eastern wall near the south corner in the Jarabacoa Deli basement; Lot 44, in the Celtic Bike Shop; and Lot 42, in the Primo Auto Body shop. All wipe samples collected at these locations showed no removable contamination. The lack of removable contamination provides assurance that workers are not inhaling or ingesting contaminant particulates when brushing up against/contacting the brick surfaces.

At each location selected for direct alpha/beta measurements, samples of the building materials were collected and sent to a subcontract laboratory for gamma spectroscopy analysis to determine the radionuclide present and their respective concentrations within the sampled material. Contamination remains in the building structures at the WACC property, primarily in the buildings that previously operated the kiln/vat in which monazite sands processing took place (Lots 42 and 44), in the basement of the deli (Lot 46), and, to a much lesser extent, in the warehouse on Lot 33 constructed above the former yard area. Contaminants are primarily embedded in the building structure with the highest concentration of Th-232 at 415.2 pCi/g and Ra-226 at 44.2 pCi/g on a sample of brick from Lot 44. The brick sample collected from Lot 33 contained Th-232 concentrations slightly above the screening criterion (1.2 pCi/g), with a concentration of 1.7 pCi/g.

Asbestos-containing material, lead based paint, and other suspect hazardous materials were also found in the WACC building structures and were comparable to a building of its age.

1.7.2 Air

The RI did not develop a screening criterion for thoron for indoor air (CDM Smith 2017a). Therefore, thoron concentrations in indoor air are compared to the outdoor criterion for thoron at 0.1 pCi/L. The RI screening criterion for radon for indoor air in the basement is 1.2 pCi/L, in the first floor is 0.5 pCi/L, and in outdoor area is 0.1 pCi/L.

1.7.2.1 WACC Buildings – Indoor Air

The 2015 RI field program did not include indoor air sampling of the WACC buildings. Therefore, the discussion below is presented as a summary of previous investigations.

A previous investigation conducted on behalf of NYCDDC in 2010 found an elevated thoron concentration of 12.7 pCi/L in the basement of the deli located on Lot 46. Two other areas surveyed included the Primo Auto Body shop on Lot 42 and the Celtic Bike Shop on Lot 44. The maximum radon and thoron concentrations from these areas, respectively, were 1.4 pCi/L and 1.6 pCi/L of radon and 0.8 pCi/L and 1.8 pCi/L of thoron. The report concluded that the low radon and thoron levels at the Primo Auto Body shop and Celtic Bike Shop are probably due to the poor airtightness of the structures (LBA 2010).

A previous investigation conducted as part of the radiation mitigation activities conducted in 2012 and 2013 collected air samples for radon before and after radiation mitigation measures (including shielding and a radon mitigation system) were installed. Air sampling conducted prior to radiation mitigation activities found the highest levels of indoor air contamination in Lots 42, 44, and 46 (where the majority of the WACC processing activities took place), at concentrations greater than the RI first floor indoor air radon screening criterion of 0.5 pCi/L, with concentrations up to 4.6 pCi/L (Weston 2016). Following radon mitigation activities, the radon levels inside Lot 42 (TerraNova) remained greater than the RI indoor air screening criterion (0.5 pCi/L) at 1.5 pCi/g. The follow up series of 2-hour continuous measurements at the same location in course of 5 days showed several instances of gas concentration increases lasting 8 – 16 hours followed gradual decreases of the same time length. The concentration fluctuations of the gas influx were recorded about 2 orders of magnitude and, over 5-day period, yielded average radon and thoron concentrations as 4.73 pCi/L and 3.41 pCi/L, respectively.

1.7.2.1 WACC Property – Outdoor Air

The 2015 RI field program did not include outdoor air sampling at the WACC property. Therefore, the discussion below is presented as a summary of previous investigations.

Thoron and radon sampling was conducted outside the WACC buildings in a 2012 neighborhood radiological assessment by New York State Department of Health, New York City Department of Health and Mental Hygiene and the EPA. According to the radon/thoron survey information and results, the highest thoron average concentration from a single location was 0.303 pCi/L at the corner of Cooper Street and Irving Avenue. The radon data were not available in the report.

Thoron and radon sampling conducted as part of an EPA investigation in 2013 (EPA 2013a) found the highest thoron concentrations from a location near the concrete pad in the former rail spur area. The thoron concentrations in this area ranged from 1.4 pCi/L to 172 pCi/L. The associated radon concentrations ranged from 0.1 pCi/L to 0.3 pCi/L. These relatively low radon concentrations are an indication that the waste material at the WACC site is the source of the elevated thoron concentrations since thoron is a decay product of Th-232, which is present at greater concentrations in the monazite sands.

1.7.2.2 338-348 and 350 Moffat Street

A supplemental investigation was performed at the 338-348/350 Moffat Street properties by EPA in 2015 for indoor and outdoor radon and thoron (EPA 2015) to determine the air concentrations at this potentially impacted commercial and residential property. Multiple locations were surveyed based on the available external gamma rate readings, presence of cracks, holes in the floors, joints between floors and walls, and other features conducive to the emanation of gas from soil.

Twelve condominium units at this property (338-348 Moffat Street) were investigated for indoor radon and thoron using the test instrument's SNIFF mode. Results were presented as the average SNIFF mode reading over the test duration. The maximum average thoron concentration inside of a residential condominium unit was 3.6 pCi/L, with an associated average radon concentration of 0.5 pCi/L. The investigation revealed a higher thoron concentration at 8.5 pCi/L in a shed-like structure containing a pottery workshop in the backyard of the property. The associated radon concentration was 0.4 pCi/L.

1.7.2.3 School and Daycare

To determine potential impacts to the P.S./I.S. 384 school and the Audrey Johnson Daycare in the neighborhood of the WACC property (see **Figure 1-2**), investigations were conducted at the properties.

As part of previous EPA investigations, single gas entry points were identified at the school and the daycare. The 30-minute survey using a RAD-7 meter of the single gas entry point in the school basement indicated a radon concentration of 17.9 pCi/L and a thoron concentration of 24.4 pCi/L (December 2010-January 2011). These investigations also reported elevated levels of thoron above the RI screening criterion in the switch room of the daycare's basement. The 2-hour survey of this single gas entry point indicated a radon concentration of 0.6 pCi/L and a thoron concentration of 2.1 pCi/L (December 2012) (EPA 2013a).

In a subsequent radon investigation conducted at the school and daycare in December 2012, radon was found in the school at a maximum concentration of 0.6 pCi/L and in the daycare at a maximum concentration of 0.6 pCi/L.

As part of the 2015 investigation activities, short-term air samples were collected in charcoal canisters for radon analysis in the school and the daycare located on Moffat Street south of the WACC property. Long-term samples for a 6-month and 1-year duration were collected for radon and thoron using alpha tracking detectors (ATDs) placed inside the school.

In the school, short-term radon concentrations in the school ranged from 0.1 pCi/L to 0.4 pCi/L. In the daycare, radon concentrations ranged from 0.2 pCi/L to 0.7 pCi/L. All short-term samples radon concentrations were below the first-floor screening criterion except for one location (first-floor, Room 4) at the daycare, with the radon concentration of 0.7 pCi/L. The six-month average radon measurements evaluated using ATDs ranged from 0.2 pCi/L to 1.3 pCi/L. The three radon samples in the basement exceeded their screening criterion of 1.2 pCi/L. Six-month average measurements for thoron were detected in two samples at 0.1 pCi/L and 0.2 pCi/L; one was equal to and one exceeded the screening criteria 0.1 pCi/L. The one-year average radon measurements ranged from 0.1 pCi/L to 1.2 pCi/L, with no samples exceeding the RI screening criterion. Thoron was only detected in one year-long sample at 0.1 pCi/L which is equal to the RI screening criterion.

Because a likely source of the previously detected high concentrations of thoron and radon at the school and daycare could not be identified at the properties, an investigation (including soil boring sample collection and continuous radon and thoron sample collection) was performed at the end of March 2017. Continuous radon and thoron samples were only collected at the daycare. Following the soil boring investigation, a 7-day continuous air survey conducted with the RAD-7 meter measured an average radon concentration of 0.3 pCi/L, which is below the radon basement RI screening criterion of 1.2 pCi/L. A 5-day continuous air survey was also conducted with the RAD-7 meter in thoron test mode; it measured an average thoron concentration of 0.6 pCi/L, which is greater than the RI screening criterion. This screening criterion is conservative since it is based on outdoor data collected as part of a perimeter survey in the absence of indoor data. Soil investigation results are discussed in **Section 1.7.3.3**.

1.7.3 Soils

The soil RI investigation included gamma scan surveys, soil boring downhole gamma scans, and soil sampling to delineate the impacted soils at the WACC property and potentially impacted nearby properties. Soil sampling was also conducted for non-radiological parameters to determine if the site had other contamination.

1.7.3.1 WACC Buildings

Radiological contamination under the WACC property buildings was encountered during previous investigations and the RI investigation. The RI screening criteria for Th-232 and Ra-226 was 1.2 pCi/g and 0.9 pCi/g, respectively. Surficial contamination (0-2 feet bgs) was found below the building on Lot 33 with a maximum Th-232 concentration of 77.4 pCi/g encountered during a 2010 investigation. The associated Ra-226 concentration for this sample was 20.7 pCi/g.

Deep contamination was found below the buildings on Lot 42 (Primo Auto Body) and Lot 44 (Celtic Bike Shop). The building on Lot 44 was the former kiln/vat building, while the building on Lot 44 was built between 1955 and 1966 over a WACC former yard area likely used for loading monazite sands into the kiln/vat building. The deep Th-232 contamination under these two buildings extends to a depth of 28 feet below ground surface (bgs) under Lot 44 at a concentration of 4.25 pCi/g, and down to 24 feet bgs under Lot 42 at a concentration of 2.63 pCi/g. The highest Th-232 concentrations observed during the RI were found in this area with maximum concentrations of 760 pCi/g and 533.8 pCi/g found below Lot 42 at 6-8 feet bgs and 10-12 feet bgs, respectively. The associated Ra-226 concentrations for these samples were 1.46 pCi/g and 2.36 pCi/g, respectively.

Concentrations of benzo(a)pyrene (BAP) exceeding the screening criterion (16 micrograms per kilogram [µg/kg]) were found throughout the shallow soils at the WACC property with concentrations ranging from 9 µg/kg to 10,000 µg/kg. BAP found as deep as 7 feet bgs may be related to former underground storage tanks (USTs) or use of the area to store demolished cars. Similar concentrations were also found at a nearby property, 308 Cooper Street.

Polychlorinated biphenyls (PCBs) (Aroclor 1260) exceeded the screening criterion (240 µg/kg) by at least an order of magnitude in three locations with a maximum concentration of 100,000 µg/kg. PCBs in the shallow soils can be related to USTs or a sump below the building in Lot 33.

Several metals were also found above their screening criteria but were mostly comparable to background indicating that the metals are likely associated with the urban fill or naturally occurring in glacial soils. There were exceedances of the RI screening criterion for selenium (36 mg/kg) in two near surface soil samples collected from Lot 42 (Primo Auto Body) and Lot 44 (Celtic Bike Shop) at concentrations of 50 mg/kg and 1,100 mg/kg, respectively. Arsenic concentrations ranged from 0.85 mg/kg to 45 mg/kg, exceeding the screening criterion of 0.68 mg/kg. Iron concentrations ranged from 1,300 mg/kg to 26,000 mg/kg, exceeding the screening criterion of 2,000 mg/kg. Arsenic and iron concentrations exceeding the screening criteria were found in all samples at all depths and within the range of levels detected at nearby properties, indicating the metals are likely associated with urban fill.

1.7.3.2 Former Rail Spur and Streets

Surficial radiological contamination was observed in the former rail spur area and in the southeastern corner of Lot 31/northern are of 350 Moffat Street (area adjacent to the Irving Avenue/Moffat Street intersection). Gamma readings were associated with elevated levels of surficial contamination of Th-232 at 43.8 pCi/g in SB-04 and at 7.5 pCi/g in SB-03, collected from the northern portion of Lot 31. The associated Ra-226 concentrations in these two samples were 5.6 pCi/g and 2.2 pCi/g, respectively. Soil borings advanced in the southern portion of Lot 31 adjacent to the Irving Avenue/Moffat Street intersection, showed elevated levels of Th-232 in surficial soil samples between 2 and 15 times the screening criterion. The maximum concentration was 19.3 pCi/g.

Irving Avenue east of the Irving Avenue/Moffat Street intersection likely contains deep contamination associated disposal of contaminated process liquors in the sewer line in this area that may have leaked to the surrounding soils. One sample collected from 10 to 12 feet bgs during the RI had a Th-232 concentration of 5 pCi/g and a Ra-226 concentration of 1.15 pCi/g. Two previous sample locations contained deeper contamination from 16 to 20 feet bgs.

The Irving Avenue/Moffat Street intersection had the highest gamma scan readings outside of the WACC property. Deeper contamination down to 8 feet bgs was observed at the intersection and the northern portion of Moffat Street at a concentration of 3.31 pCi/g of Th-232 and 2.31 pCi/g of Ra-226. Soil samples from a soil boring advanced in the middle of the intersection of the two streets (SB-50) found 209.93 pCi/g of Th-232 and 38.65 pCi/g of Ra-226 in the top 1 foot of soil.

Levels of contamination on Moffat Street moving south away from the WACC property generally decreased. Elevated concentrations of Th-232 and Ra-226 were observed in mostly surficial samples collected from 0 to 2 feet bgs. Two soil borings located in gamma reading hotspots, SB-36 and SB-51, had elevated surficial Th-232 at 28.55 pCi/g and 59.35 pCi/g and Ra-226 at 5.55 pCi/g and 11.13 pCi/g, respectively. Soil observations at these locations showed potential waste tailings in the top foot of soil. Approximately 40 feet south from the hotspot on Moffat Street, gamma readings drop to just above or within background levels.

1.7.3.3 School and Daycare

Four of the 30 school area soil samples were slightly above the RI screening criterion for Th-232 (1.2 pCi/g), with a maximum concentration of 1.6 pCi/g. Ra-226 was not detected above the screening criterion. Because a likely source of the previously detected high concentrations of thoron and radon at the school and daycare could not be identified at the properties, additional investigation (including soil boring sample collection and continuous radon and thoron sample collection) was performed at the end of March 2017.

Of the 10 soil borings advanced as part of the 2017 investigation activities, 5 soil borings were advanced below the school's basement, 2 were advanced below the daycare's basement, and 3 soil borings were advanced outside of the daycare on the sidewalk. Results from soil samples collected below the school's basement and below the daycare's basement were all below the RI screening criteria for Th-232 and Ra-226. In the three borings installed adjacent to the daycare building on the Moffat Street sidewalk, Th-232 exceeded the RI screening criterion in one sample which was collected from 6 to 8 feet bgs at SCSB-19. Ra-226 exceeded the RI screening criterion in three samples, ranging from 0.98 pCi/g to 1.18 pCi/g. The RI concluded that these concentrations are more likely due to varied fill material in the subsurface in this area with naturally occurring higher radionuclide concentrations. The surface soil samples at these locations were all below the RI screening criteria.

Gamma exposure rates collected from within the school and daycare were all within or below the background observed for the neighborhood.

1.7.3.4 308 Cooper Street

A gamma scan was performed at this property, and a total of eight borings (six shallow and two deep) were advanced by direct-push technology on this adjacent empty lot. Shallow soil borings were generally advanced to 10 feet bgs and the deep soil borings were 25 to 30 feet bgs.

The gamma walk-over survey at 308 Cooper Street showed most of the activity at this property is only slightly above background levels, except the northeastern corner of the property, which had readings at least twice background levels. Results from a boring in the eastern corner of this property showed Th-232 and Ra-226 concentrations above the screening criteria at 6.4 pCi/g and 1.7 pCi/g, respectively, in the surficial soil sample. Three other surficial soil samples were above the screening criterion for Th-232 with the maximum concentration of 1.5 pCi/g. Five samples at depths ranging from 2 to 26 feet bgs had Th-232 concentrations only slightly greater than the screening criterion, with a maximum concentration of 1.9 pCi/g from 2 to 2.6 feet bgs at a boring in the northeast portion of the property.

1.7.3.5 338-348 and 350 Moffat

A gamma scan was performed at this property. Additionally, a total of 15 shallow borings were advanced to depths between 1 and 10 feet bgs inside the warehouse and hallways of the apartments, and outside in the open back lot areas.

The gamma readings at this property were mostly within background levels. Soil samples collected from borings through the floors of the property buildings showed slightly elevated concentrations of both Th-232 and Ra-226 from 0 to 10 feet bgs, but less than 2 times the screening criteria. The maximum concentrations of Th-232 and Ra-226 were 2.4 pCi/g and Ra-226 1.8 pCi/g, respectively.

Soil sampling results showed Th-232 concentrations were slightly elevated, but less than two times the screening criterion, in a majority of the soil samples. However, toward the northeast corner of the building adjacent to the southern corner of Lot 31, soil gamma readings were elevated with counts greater than four times background. A soil sample collected from 0 to 2 feet bgs in this area had Th-232 at 4.9 pCi/g, and Ra-226 at 3.2 pCi/g, confirming the gamma scan reading.

These buildings were not present when WACC was in operation. The low levels of soil contamination may indicate that contaminants from the WACC property migrated offsite due to surficial runoff into this area or that contaminated soils were used to grade and fill the area prior to construction of the buildings.

1.7.4 Sewers

The sewer investigation found significant radionuclide contamination present in the CSS originating at the WACC property. At each manhole along the path of the sewer lines investigated, the manhole cover was removed and a one-minute total counts measurement and a gamma exposure rate measurement was collected at the surface. The entire depth of the sewer vault was then scanned and another one-minute gamma count was collected three feet from the bottom of the sewer invert and at the depth of the maximum gamma count rate. Gamma count measurements are significantly elevated (gamma levels greater than 100,000 cpm) in the manholes south of the WACC buildings on Irving Avenue where process liquors containing thorium were likely discharged. The elevated gamma counts (greater than [>] 20 times background) continue in the sewer line and manholes on Irving Avenue for approximately two blocks to Decatur Street. Gamma levels within the CSS generally drop to four times background at the intersection of Irving Avenue and Schaeffer Street and drop to background at the intersection of Irving Avenue and Eldert Street, with sporadic occurrences of gamma levels above four times background continuing in the sewer along Halsey Street to Wyckoff Avenue.

Radionuclide contamination within the pipes and the manholes is present in sediments and construction materials in the sewer manholes near the WACC property. The maximum radionuclide concentrations in sewer manhole construction materials were found in manhole I-4, located near the intersection of Irving Avenue and Cooper Avenue, with Th-232 at 2,536.2 pCi/g and Ra-226 at 163.1 pCi/g. The maximum Th-232 concentration in sewer sediments was observed in manhole I-2, located south of the WACC property on Irving Avenue, with Th-232 at 1,218.1 pCi/g and Ra-226 at 45.9 pCi/g. The sewer investigation results are presented in **Appendix A**, Figure 4-7.

Radionuclide contamination (Th-232, Ra-226) appeared limited to the interior of the sewers as soil borings installed adjacent to the sewer lines found only limited radionuclide contamination. A data gap does remain as the bedding material below the sewers may be contaminated. The bedding material is a major migration pathway as leaking water from the sewer migrates in the more permeable backfill over long distances. The sewer fiberscope survey confirmed that there are breaks in the pipeline along Irving Avenue.

Sewer outfall - Newtown Creek sediment - Sediment concentrations at the Newtown Creek sewer outfall were above the Th-232 screening criterion with a maximum concentration of 70.2 pCi/g from 5 to 6 feet below the bottom of the river. Samples exceeding the criterion were limited to the area immediately adjacent to the outfall discharge.

1.7.5 Groundwater

Th-232 contamination in the groundwater was limited to one groundwater sample that only slightly exceeded the screening criterion for Th-232 (a surrogate for Ra-228) and Ra-226 (5 pCi/L) during the Round 2 sampling at 11 pCi/L. However, Round 1 and Round 2 samples were analyzed with methods that did not provide a minimum detectable activity (MDA) that was below the RI screening criteria. Therefore, additional sampling was necessary to acquire definitive data.

Round 3 and Round 4 sampling events were performed with samples analyzed by different methods to achieve lower MDAs. Round 4 included the sampling of a then-recently installed upgradient well. Ra-226 and Th-232 were not detected above the RI screening criteria in Round 3 and Round 4. The data and these observations suggest the groundwater at the WACC site is not impacted above the screening criteria.

Chlorinated volatile organic compounds (CVOCs), including tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE), exceeded screening criteria in the groundwater at each of the six monitoring wells including the upgradient well. Therefore, the RI concluded that CVOCs in groundwater at the site are likely from an upgradient source.

1.7.6 Gamma Exposure Rate Surveys

Gamma exposure rate surveys confirmed the results from the previous gamma exposure rate surveys conducted within the WACC buildings, on sidewalks, and on the streets near the WACC property. Exposure rates remain above background levels throughout each of these areas, but were within the background range outside of a few blocks from the WACC property. The maximum gamma exposure rates observed were collected on Irving Avenue south of the WACC property at 220 μR/hr near the sidewalk curb and 338 μR/hr in the middle of the street. These readings were taken at waist height or approximately three feet above the ground surface.

The gamma exposure rates collected from within the school and daycare were all within or below the background observed for the neighborhood.

1.8 Conceptual Site Model

The conceptual site model (CSM) follows the movement of the primary radionuclides from the monazite sands processing to the site media, including the building structures, soils, sewers, air, and groundwater. **Figure 1-8** presents an illustration of the CSM.

Sources of Radionuclide Contamination

The sources of radionuclide contamination are the monazite sands and the monazite sands processing byproducts (process liquors and waste tailings). The sands were transported by rail to the rail spur adjacent to the property and were stockpiled in the southern former storage yard. From here, they were moved to the yard adjacent to the former kiln vat building and entered processing through the archways of the kiln vat building that are still present. The monazite sand processing to increase the concentration of rare earth metals in the final product took place in the kiln/vat building.

Byproducts of the production process, including process liquors and process tailings, contained high concentrations of radionuclides. The former storage yards were likely used to stockpile and dispose of these tailings; the tailings were also used to fill low areas in and around the WACC property.

Pathways for Contaminant Release/Transport

Soil contamination resulting from process liquor disposal – Soil contamination around and below the sewer connection below buildings on Lots 42 and 44 is likely attributable to process liquor exfiltration via leaky drains and sewer pipes, and material handling within or adjacent to the kiln/vat building. Once the process liquor entered the soil matrix, it traveled downward through the soil column. The radionuclides dissolved in sulfuric acid were mobile and were transported to an observed 26 feet bgs in the soils. The tendency is for radionuclides to form low-solubility and immobile compounds, except in the presence of low pH. When the pH of the sulfuric acid containing the more soluble and mobile radionuclides was neutralized by the soil in the subsurface, the radionuclides formed relatively immobile and low-solubility precipitates or compounds. Therefore, the process liquor migration slowed in the soil column with depth.

Sewer contamination resulting from process liquor disposal – Upon entering the CSS, the process liquors were diluted with incoming sewer water from other sewer branches. The radionuclides formed relatively immobile and low-solubility precipitates or compounds, traveling with the sediment downstream in the sewers or accumulating within the sewers as sludge or sediment within the sewer structures. Radionuclides also absorbed to the construction materials, staying in the matrix of the construction materials. Additionally, in areas of comprised integrity, radionuclides potentially migrated through leaks in the pipeline.

Soil contamination resulting from stockpiling, handling, and filling – Monazite sands were unloaded from the rail spur and stockpiled in the former storage yards along with the process tailings. Handling of the sands and tailings likely spread them throughout the soil surface of the yard and rail spur areas. Surficial runoff likely transported the sands and waste tailings from localized areas in the storage yards to downgradient areas near the property including the former rail spur, the Moffat Street and Irving Avenue intersection, and 338-340 and 350 Moffat Street. Additionally, transport of radionuclide-laden dust and particulates from the uncovered stockpiles in the air likely contributed to the surficial soil contamination found in the adjacent properties.

Contamination at depth below the Irving Avenue/Moffat Street intersection, Irving Avenue, and Moffat Street, potentially migrated from the WACC property by being utilized as fill during either road construction or sewer construction.

Human and ecological receptors

Human receptors may be exposed to the principal radionuclides through the following: direct contact with contaminated building materials, contaminated soils, waste tailings, and contaminated sewer materials; external radiation in areas of high radiation emanating from the previously mentioned contaminated materials; and, inhalation of radon- and thoron-contaminated air.

Th-232 was detected in sediment at the Newtown Creek outfall below biota concentration guides/no further actions levels developed as part of the ecological screening evaluation. Ecological receptors, which are only present in Newtown Creek and not at the site, could be exposed to the radionuclides in the aquatic system through direct contact with the sediments at the Newtown Creek outfall.

1.9 Risk Assessments

The site-specific human health risk assessment (HHRA) (CDM Smith 2017b) and screening level ecological risk assessment (SLERA) (CDM Smith 2017c) are summarized below.

1.9.1 Human Health Risk Assessment

The HHRA is developed to characterize potential human health risks associated with the site in the absence of any remedial action. The HHRA was conducted in accordance with the RI work plan and current EPA guidance outlined in *Risk Assessment Guidance for Superfund (RAGS)*, Parts A, D, E, and F and other EPA guidance pertinent to human health risk assessments.

Exposure Assessment

Potential exposure pathways at the site are defined based on source areas, release mechanisms, and current and potential future uses of the site. Potential current and future receptors evaluated in the risk assessment include:

- Workers (commercial indoor and industrial)
- Trespassers
- Public users of the property
- Nearby residents and workers
- School children
- Construction/Utility Workers (future only)
- On-property residents (future only)

Exposure routes evaluated for the above receptors include:

- External radiation from surface and subsurface soil, outdoor surfaces, and interior surfaces
- Direct contact with radionuclides in surface and subsurface soil (i.e., ingestion, inhalation, and external radiation)
- Direct contact (occasional entry by utility workers) with radionuclides in sewer sediment (i.e., ingestion and external radiation)
- Inhalation of ambient air during exposure to sewer sediment
- Inhalation of radon and thoron in indoor air
- Direct contact with chemicals in surface and subsurface soil (i.e., incidental ingestion, dermal contact, and inhalation of particulates)
- Direct contact with chemicals in groundwater used as drinking water (i.e., ingestion, dermal contact, and inhalation)

- Inhalation of vapors (VOCs) emanating from groundwater
- Consumption of homegrown produce

Not all the above exposure pathways are evaluated for every receptor. In addition, some pathways are evaluated only qualitatively (e.g., vapor intrusion).

Exposure areas consider the spatial scale over which exposure occurs related to current and possible future activities. The former WACC is a complex mixture of individual properties (lots) and facilities. Exposure areas include the former WACC property individual lots, Moffat Street, Irving Avenue, and Cooper Street/Avenue. Within this site, an early action has increased the complexity of assessing exposure within areas by the addition of shielding in some areas but not all areas, as well as the use of different shielding materials (lead and concrete).

Quantification of exposure includes evaluation of exposure parameters that describe the exposed population (e.g., contact rate, exposure frequency and duration, and body weight). Each exposure parameter in the equation has a range of values. The HHRA estimated exposures for receptors based on the reasonable maximum exposure (RME) scenario (the highest exposure reasonably expected to occur at a site). The intent is to estimate a conservative exposure case that is still within the range of possible exposures.

Toxicity Assessment

Chemicals of potential concern (COPCs) are quantitatively evaluated based on their noncancer and/or cancer potential. Radionuclides of potential concern (ROPCs) are quantitatively evaluated based on their cancer potential. The reference dose and reference concentration are the toxicity values used to evaluate noncancer health hazards in humans. Inhalation unit risk and slope factor are the toxicity values used to evaluate cancer health effects in humans. These toxicity values are obtained from various sources following the hierarchy order specified by EPA. Cancer slope factors provided in the RESidual RADioactivity, DOE computer model (RESRAD) Onsite Version 7.2 model and in the online EPA PRG Calculator for Radionuclides were used for radionuclides**.**

Risk Characterization

Risk characterization integrates the exposure and toxicity assessments into quantitative expressions of risks/health effects. To characterize potential noncancer health effects, comparisons are made between estimated intakes of substances and toxicity thresholds. Potential cancer effects are evaluated by calculating probabilities that an individual will develop cancer over a lifetime exposure based on projected intakes and chemical-specific dose-response information. In general, EPA recommends target risk values, (i.e., cancer risk of 10^{-6} [1 in 1 million] to 10^{-4} [1 in a 10,000] or a noncancer health hazard index [HI] of unity [1]), as threshold values for potential human health impacts. These target values aid in determining whether remedial action is necessary at the site.

Risks for all receptors are estimated using RME assumptions. Risks due to exposure to non-radioactive COPCs are also estimated using central tendency exposure (CTE) assumptions when the RME assumptions result in risk estimates above EPA's thresholds. Radiological risk to all receptors was assessed using RESRAD Onsite Model Version 7.2, a model developed and maintained by Argonne National Laboratory. The online EPA PRG Calculator for Radionuclides was also used to evaluate radiological risk for scenarios with the highest risk for comparison purposes. Estimated risks are summarized below.

Current Receptors Chemical Risk

Due to the developed nature of the site, direct exposure to COPCs in soil is limited for current receptors. In addition, groundwater is not currently used for any purpose at or near the site; therefore, direct exposure to contaminants in groundwater was not evaluated for current receptors. However, exposure to VOCs in groundwater via vapor intrusion was qualitatively evaluated by comparing maximum concentrations of VOCs in groundwater to EPA Vapor Intrusion Screening Levels (VISLs) for groundwater. This analysis found that VOCs are present at concentrations in groundwater exceeding VISLs. However, this finding is based on default assumptions that may overestimate the potential for exposure from vapor intrusion.

Current Receptors Radiation Risk

Complete exposure pathways for current receptors to ROPCs include external radiation from soil, external radiation from outdoor and indoor surfaces, and inhalation of radon and thoron in indoor air. Cancer risks were estimated initially using RESRAD to screen risk across multiple pathways and time-frames. Subsequently, the EPA's PRG calculator was used to provide risk managers with risk estimates for important exposure scenarios (current and future workers, future residents). Non-radon-related cancer risk for commercial indoor workers and industrial workers exceeds EPA's target cancer risk range, primarily due to external exposure to Th-232 (over 90 percent), with the majority of the remaining fraction associated with Ra-226. Inhalation and soil ingestion pathways make negligible contribution to risk. Cancer risk due to exposure to radon was estimated to be significantly higher than exposure to external gamma radiation. Exposure to thoron was estimated to be about two orders of magnitude lower than exposure to radon and was in the 1×10^{-5} range. EPA installed shielding in most of the work areas and radon/thoron mitigation systems in some areas on the WACC property in 2013. Shielding was effective in reducing annual exposure to current workers.

High risk estimates (above 1×10^{-4}) for current workers suggest some potential for the general public to experience exposure above regulatory thresholds. The general public would encompass people visiting sidewalks along streets at and near the site where radionuclides have been transported as well as people frequenting businesses at and near the site. Possible exposure for the general public is mitigated by the installation of steel and lead shielding in some sidewalk areas where soil contamination is greatest.

People living and working in the neighborhood, particularly those receptors that spend significant time along streets where radionuclides were transported in and, perhaps, around sewer lines may be exposed to contamination present in the area. Exposures are likely to be less than exposures for indoor workers at the site for three reasons. First, little near-surface contamination is present, and the vadose zone and sidewalks and other hardscape will provide shielding. Second, radiological contaminants in the sewer sediments are more diffuse and well shielded by the piping and overlying street pavement. Third, people will spend less time than indoor or industrial workers on the streets above site-related contamination.

Future Receptors Chemical Risk

Future on-property residents and industrial workers were quantitatively evaluated for exposure to COPCs in surface soil. Cancer risk exceeds EPA's target threshold for future residents and is at the upper end of EPA's target range for industrial workers. The primary COPC cancer risk drivers are Aroclor 1260 and benzo(a) pyrene in surface soil. Hot spots for these COPCs are present on the WACC property. Noncancer health hazards associated with exposure to surface soil for future residents exceed the target threshold due to exposure to Aroclor 1260 (which affects the ocular, dermal, and immune systems) and selenium (which affects the nervous system, blood, and skin). Noncancer health hazards associated with exposure to surface soil for future industrial workers also exceed the target threshold due to exposure to Aroclor 1260.

Future on-property residents and commercial indoor workers were also quantitatively evaluated for exposed to COPCs in groundwater used as drinking water. Groundwater is not currently used for drinking water at the site. Future potable use of groundwater is unlikely because a municipal water supply is readily available and serves the site and vicinity. Cancer risk exceeds EPA's target threshold for future residents due to exposure to hexavalent chromium assumed to be present in groundwater based on total chromium measurements. Cancer risk for future commercial indoor workers is at the upper end of EPA's target range. Noncancer health hazards for both future residents and commercial indoor workers exceed EPA's target threshold due to future hypothetical use of groundwater as drinking water. Health hazards are primarily due to exposure to PCE and TCE; PCE affects the liver and TCE affects the kidneys.

Cancer risk for future construction/utility workers exposed to COPCs in surface/subsurface soil is within EPA's target range of 1×10^{-6} to 1×10^{-4}. Noncancer health hazards associated with exposure to surface/subsurface soil for future construction/utility workers exceed the target threshold due to exposure to Aroclor 1260.

Exposure to VOCs in groundwater via vapor intrusion was qualitatively evaluated as discussed for current receptors and found similar results. However, similar for risk to current receptors, this finding is based on default assumptions that may overestimate the potential for exposure from vapor intrusion.

Future Receptors Radionuclide Risk

The total cancer risk estimate for all exposure pathways is 2×10^{-2}. About half of this risk is associated with consumption of home grown produce, Radon inhalation accounts for about one-third of this risk, and external exposure accounts for slightly less than one quarter of this risk.

Total cancer risk for future on-property residents, excluding radon and the consumption of home grown produce hover around 5×10^{-3} throughout the 1,000-year period evaluated. Cancer risk, when radon and consumption of home grown produce is excluded, was dominated by external exposure, which accounts for 80 to 90 percent of estimated risk. Th-232 was responsible for most (>90 percent) of the risk due to external exposure. Radon alone may present risks similar to risks from external exposure. Risk reduction measures for Th-232 and Ra-222 are different and separate risk estimates for these two pathways facilitate estimates for risk reduction in alternative analyses. Note that Rn-220, a daughter of Th-232, is also called thoron to distinguish it from Rn-222 in the U-238 decay chain. The term "radon" in this assessment includes both Rn isotopes, but Rn-222, a daughter of Ra-226, is typically responsible for all risks associated with radon emanation.

Risk estimates from the PRG Calculator are reasonably similar to the above results from RESRAD modeling. The Calculator suggests risks in excess of 1×10^{-4} by an order of magnitude or more, with Th-232 as the major component of radiological risk due to external exposure (Th-232).

Risks for both future indoor and industrial workers are anticipated to be much the same as risks for current workers. Any future commercial or industrial construction is likely to have a substantial on-slab foundation, which should provide much the same shielding as the shielding previously put in place. Total cancer risk for future workers considering shielding from a foundation and, excluding radon, ranged to 3×10^{-3} and to 4×10^{-3}. Cancer risks for future workers assuming no cover of the contaminated zone range may be as high as 5×10^{-3}.

Future development of the site would require construction workers to be onsite without benefit of shielding on a full-time basis. Although this exposure is short-term, taking place within a single calendar year, ground shine (emitting radiation) and contact with contaminated soils would be intimate. Cancer risk for construction workers would be about 5×10^{-5}. For utility workers exposed to sewer sediment, cancer risk would be about 2×10^{-4}.

Future risks for the general public and for offsite receptors are assumed to be similar to current risks for these receptors. No changes to the surrounding neighborhood were contemplated in the conceptual site model for the site, and without remediation, half-lives of radionuclides are high enough to maintain existing exposure levels for an extended period. High risk estimates (above 1×10^{-4}) for workers suggest some potential for the general public to experience exposure above regulatory thresholds.

High cancer risk estimates are not unusual for radiological contaminants in an environmental setting. Background levels of radiation exposure in residential settings can be associated with risks approaching and often exceeding EPA's risk range. Risk estimates can also be interpreted in terms of annual radiation dose, which is a common means of assessing health risk in the nuclear physics community. The highest annual dose estimates, which approach or exceed 100 millirems (mrem), also exceed typical risk screening levels of 12 and 25 mrem/year for residential and occupational exposure, respectively.

1.9.2 Screening Level Ecological Risk Assessment Summary

The site is in an industrial area with no environmentally sensitive areas (e.g., wetlands) and only limited habitat for most types of ecological receptors; thus, adverse exposures for ecological receptors at the site are unlikely. Due to the extremely limited habitat, a full SLERA was not conducted; instead a focused screening evaluation was conducted. The purpose of this focused SLERA is to describe the likelihood, nature, and extent of adverse effects in ecological receptors exposed to site-related radionuclides resulting from releases to the environment from past processing activities at the site. Because CSO discharges from the site may contain thorium waste from monazite sand processing, this evaluation focused on risks to ecological receptors exposed to the site-related CSO discharges in Newtown Creek (approximately 1.9 miles to the northwest). Newtown Creek is a tidal arm of the New York-New Jersey Harbor Estuary.

Receptors that could be exposed to radionuclides in the aquatic ecosystem include aquatic and riparian vegetation, aquatic animals, riparian animals, and other animals that use aquatic resources. It was determined that the generic riparian animal was the limiting organism for the sediment exposure pathway. External dose exposure pathways for riparian animals include exposure to radionuclides in sediment and exposure to radionuclides in water. Internal dose exposure pathways include: exposure to radionuclides via ingestion of contaminated vegetation, including water content with dissolved nutrients and minerals, and exposure to radionuclides biomagnified through the food web.

Sediment data collected during the RI were used to evaluate potential exposure to aquatic biota by comparing the results to screening criteria determined using the RESRAD-BIOTA model. The RESRAD-BIOTA model was used to estimate sediment biota concentration guides (BCGs) for riparian receptors. BCGs define doses below which risks to populations are assumed not to occur.

Maximum and mean radionuclide concentrations measured in sediment were compared to BCGs for riparian animals in the aquatic ecosystem. The results of the screening evaluation verify that radionuclide concentrations in sediment in the East Branch of Newtown Creek are significantly less than BCGs and that dose to receptors is below biota dose limits. The bulk of measured radioactivity in sediment is likely due to natural background of radionuclides except for the thorium isotopes (i.e., Th-228, Th-230, and Th-232) and their progeny; further supporting conclusions of low or insignificant risk to ecological receptors are observations that the site and nearby areas provide only limited ecological habitat.

1.10 Data Gaps

Although the RI data are considered sufficient to develop and evaluate remedial alternatives for contaminated media at the site, additional data would be needed to fully develop a remedial design and costs. The following categories of data would need to be collected:

- Delineation of radionuclide contamination in soils was not achieved in areas adjacent to the cabinet maker (Lot 30) to the north of the WACC property suggesting potential concentrations above screening criteria may exist below the building.
- A full areal delineation of radionuclide contamination in soils within the WACC buildings footprints and adjacent sidewalk and streets was not achieved due to a limited number of borings being completed in these areas. Contaminant concentrations above screening criteria potentially may exist in these locations.
- The sewer pipeline on Irving Avenue showed potential for exfiltration in several areas as indicated by the fiberscope investigation. Contamination was not observed in soil samples collected adjacent to the pipeline; however, samples were not collected from the bedding material below the sewer. This bedding material has the potential to be contaminated.

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Section 2

Development of Remedial Action Objectives and Screening of Technologies

RAOs are media-specific goals for protecting human health and the environment. They serve as the basis for the development of remedial action alternatives and specify what the cleanup action will accomplish. The process of identifying the RAOs follows the identification of affected media and contaminant characteristics and the evaluation of exposure pathways, contaminant migration pathways, and exposure limits to receptors. The RAOs are based on regulatory requirements and risk-based evaluation, which may apply to the various remedial activities being considered for the site. This section reviews the affected media and contaminant exposure pathways and identifies federal, state, and local regulations that may affect remedial actions.

Preliminary remediation goals (PRGs) were developed based on federal- or state-promulgated ARARs, risk-based levels (human health), and background concentrations, with consideration also given to other requirements such as analytical detection limits and guidance values. These PRGs were then used as benchmarks in the technology screening, alternative development and screening, and detailed evaluation of alternatives presented in the subsequent sections of the FS report.

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended, requires that, at a minimum, any remedial action must achieve overall protection of human health and the environment and comply with ARARs. Other criteria that do not meet the definition of an ARAR are known as to be considered (TBC) criteria, which may also be used to develop RAOs and be considered during evaluation of remedial alternatives.

The remedial action alternatives developed in subsequent sections of this FS are required to attain applicable federal, State of New York, and local environmental requirements. Technical requirements of ARARs must be met by the remedial action alternatives. However, 40 Code of Federal Regulations (CFR) 121(d)(4) allows selection of remedies that will not attain all ARARs provided one of the following conditions is satisfied:

- The remedial action is an interim measure where the final remedy will attain the ARAR upon completion.
- Compliance with all ARARs will result in greater risk to human health and the environment than other options.
- Compliance is technically impracticable.
- The remedial action will attain the equivalent of the ARAR.
- For state requirements, the state has not consistently applied the requirement in similar circumstances.

- Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the site and the availability of funding for response at other facilities (fund balancing).

ARARs apply to actions or conditions located onsite and offsite. Onsite actions implemented under CERCLA are exempt from administrative requirements of federal and state regulations (such as permits) if the substantive requirements of the ARARs are met. Offsite actions are subject to the full requirements of the applicable standards or regulations (including all administrative and procedural requirements).

Based on the CERCLA statutory requirements, the remedial actions developed in this FS would be analyzed for compliance with federal and state environmental regulations. This process involves the initial identification of potential requirements, the evaluation of the potential requirements for applicability or relevance and appropriateness, and finally, a determination of the ability of the remedial alternatives to achieve the ARARs.

2.1 Development of Remedial Action Objectives

The process for developing RAOs follows the identification of contaminants of concern (COCs) for each media, identification of potentially applicable or relevant and appropriate federal and state regulations and other guidance, development of human health and ecological risk-based cleanup levels, and finally, selection of the PRGs based on the ARARs, guidance values, risk-based values, or background concentrations. Generally, where a chemical-specific ARAR exists, it provides the basis for the corresponding PRG; if more than one applicable chemical-specific ARAR exists, the most stringent applicable requirements are generally applied first. The selected PRGs are levels of COCs that will be protective of human health and the environment and provide the basis for the evaluation of remedial technologies. A detailed discussion of the contaminants and media of concern and development of RAOs is provided below.

2.1.1 Contaminants and Media of Concern

Defining the media and COCs at the site is a prerequisite to developing site-specific RAOs and GRAs. RAOs often target specific media for cleanup to protect human health and the environment. In addition, ARARs and TBC information are generally specified based on media and COCs. For example, identifying soil as a medium of concern would require that state and federal soil regulations be considered as ARARs.

2.1.1.1 Selection of Contaminants of Concern

As part of the RI/FS, an HHRA and a focused SLERA were conducted to determine if any threat to public health, welfare, or the environment may exist resulting from the release or threatened release of contaminants at or from the WACC site.

Radiological Human Health Risk Drivers

As noted in Section 1.9.1, for current receptors, non-radon-related cancer risk for commercial indoor workers and industrial workers exceeds EPA's target cancer risk range, primarily due to external exposure to Th-232 (over 90 percent), with the majority of the remaining fraction associated with Ra-226. For future on-property residents, the total cancer risk estimate for all exposure pathways is 2×10^{-2}. Risks for both future indoor and industrial workers are anticipated to be much the same as risks for current workers. Total cancer risk for future workers considering shielding from a foundation and, excluding radon, ranged to 3×10^{-3} and 4×10^{-3}, including radon. Cancer risks for future workers assuming no cover of the contaminated zone range as high as 5×10^{-3}.

Chemical Human Health Risk Drivers

As noted in Section 1.9.1, cancer risk from exposure to chemical contaminants exceeds EPA's target threshold for future residents and is at the upper end of EPA's target range for industrial workers. The primary COPC cancer risk drivers are Aroclor 1260 and benzo(a) pyrene in surface soil. Hot spots for these COPCs are present on the WACC property. Noncancer health hazards associated with exposure to surface soil for future residents exceed the target threshold due to exposure to Aroclor 1260 and selenium. Noncancer health hazards associated with exposure to surface soil for future industrial workers also exceed the target threshold due to exposure to Aroclor 1260. The exceedances of the RI screening criterion for selenium (36 mg/kg) were limited to two near surface soil samples collected from Lot 42 (Primo Auto Body) and Lot 44 (Celtic Bike Shop) where radiological contamination is the primary risk driver. As a result, risks from selenium will be addressed through the remediation of radiological contaminants.

Future on-property residents and commercial indoor workers were also quantitatively evaluated for exposure to COPCs in groundwater used as drinking water. Chemical risk drivers in groundwater at the site include hexavalent chromium, PCE, and TCE, however, the risk due to exposure to hexavalent chromium in groundwater is most likely overestimated because the HHRA assumes that hexavalent chromium is present in groundwater based on total chromium measurements. In addition, the presence of chlorinated VOCs in an upgradient well suggests that PCE and TCE contaminant plumes may originate from upgradient sources and are not likely to be site-related. Finally, as indicated in Section 1.9.1, groundwater is not currently used for drinking water at the site and future potable use of groundwater is unlikely because a municipal water supply is readily available and serves the site and vicinity.

Ecological Risk

As indicated in Section 1.9.2, the SLERA noted that the site is in an industrial area with no environmentally sensitive areas (e.g., wetlands) and only limited habitat for most types of ecological receptors; thus, adverse exposures for ecological receptors at the site are unlikely. The results of the screening evaluation also verify that radionuclide concentrations in sediment in the East Branch of Newtown Creek are significantly less than BCGs and that dose to receptors is below biota dose limits.

2.1.1.2 Media of Concern

Media of concern include the WACC building materials, soils underlying the WACC buildings, and surficial and subsurface soils extending beyond the WACC buildings. Additional media of concern include sediments/sludge and the sewer pipes and manhole materials within the CSS near the WACC property. As noted in Section 1, radiological contamination is present in these media. Soil contamination also includes chemical risk drivers benzo(a)pyrene and Aroclor 1260.

Indoor air is also considered a media of concern. As noted in Section 1.6.2, air sampling conducted prior to radiation mitigation activities found the highest levels of indoor air contamination in Lots 42, 44, and 46 (where the majority of the WACC processing activities took place) at concentrations greater than the RI first floor indoor air radon screening criterion of 0.5 pCi/L. (Weston 2016). Following radon mitigation activities, the radon levels inside Lot 42 (TerraNova) remained greater than the RI indoor air screening criterion. The follow up series of 2-hour continuous measurements at the same location in course of 5 days showed several instances of gas concentration increases lasting 8 – 16 hours followed gradual decreases of the same time length. The concentration fluctuations of the gas influx were recorded about 2 orders of magnitude and, over 5-day period, yielded average radon and thoron concentrations as 4.73 pCi/L and 3.41 pCi/L, respectively (Weston 2016).

For the reasons indicated in Section 2.1.1.1, groundwater is not considered a media of concern.

2.1.1.3 Media and COCs to be Addressed

Based on the discussion above, RAOS, PRGs, and remedial alternatives have been developed to address the following media and COCs for this site:

- Soils/solids (including building material, sewer pipe, sediment in sewers)
  - Chemicals (soils only): benzo(a)pyrene and Aroclor 1260
  - Radionuclides: Th-232 and Ra-226
- Air (indoor): Radon and Thoron

2.1.2 Remedial Action Objectives

The following RAOs have been proposed to mitigate the potential present and/or future risks associated with exposure to contamination in the site buildings, soils, and sewer pipe.

- WACC and other impacted buildings
  - Reduce or eliminate human exposure via inhalation of radon and thoron, incidental ingestion, dermal adsorption, and external exposure to radiological contamination (Ra-226 and Th-232) present within the buildings to levels protective of current and anticipated future use by preventing exposure to contaminant levels above PRGs.
- Soils/solids (solids include sewer pipe, sediments/sludge in sewer and site material at off-property locations)
  - Reduce or eliminate the human exposure threat via inhalation, incidental ingestion, dermal adsorption, and external exposure to contaminated site soils and solids to levels protective of current and anticipated future land use by preventing exposure to benzo(a)pyrene, Aroclor-1260, Ra-226 and Th-232 to concentrations above PRGs.
  - Prevent/minimize the migration of site contaminants offsite through surface runoff, dust particulate migration, and CSS discharge.

2.2 Potential ARARs, Guidelines, and Other Criteria

CERCLA requires that onsite remedial actions attain or waive federal environmental ARARs, or more stringent state environmental ARARs, upon completion of the remedial actions. Along with the protection of human health, attainment of ARARs is considered threshold criteria under CERCLA. The purpose of ARARs is to define the minimum level of protection that must be provided by a remedy selected and implemented. Additional protection may be required, if necessary, to protect human health and the environment.

2.2.1 Definition of ARARs

ARARs are designated as either "applicable" or "relevant and appropriate," according to the National Contingency Plan (NCP). A requirement under CERCLA, as amended, may be either "applicable" or "relevant and appropriate" to a site-specific remedial action, but not both. The distinction is critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA.

If a state or federal environmental law is determined to be either applicable or relevant and appropriate, compliance with the substantive requirements of that ARAR are mandatory under CERCLA and the NCP. Compliance with ARARs is a threshold criterion that any selected remedy must meet unless a legal waiver as provided by CERCLA Section 121(d) (4) is invoked.

2.2.1.1 Applicable Requirements

Applicable requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Applicable requirements are defined in the NCP, at 40 CFR 300.5 – Definitions.

2.2.1.2 Relevant and Appropriate Requirements

Relevant and appropriate requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site per se, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate. Relevant and appropriate requirements are defined in the NCP, at 40 CFR 300.5 – Definitions.

The determination that a requirement is relevant and appropriate is a two-step process that includes: (1) the determination if a requirement is relevant and (2) the determination if a requirement is appropriate. In general, this involves a comparison of several site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action, the medium and substances regulated by the requirement and the proposed requirement, the actions or activities regulated by the requirement and the remedial action, and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA 1988).

2.2.1.3 Other Requirements to Be Considered

These requirements pertain to federal and state criteria, advisories, guidelines, or proposed standards that are not generally enforceable but are advisory and that do not have the status of potential ARARs. Guidance documents or advisories "to be considered" (TBCs) in determining the necessary level of remediation for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation or where such ARARs are not sufficient to be protective.

2.2.1.4 Classifications of ARARs

Three classifications of requirements are defined by EPA in the ARAR determination process. An ARAR can be one or a combination of all the following three types of ARARs:

- Chemical-specific
- Location-specific
- Action-specific

Chemical-specific ARARs include those laws and regulations governing the release of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These ARARs and TBCs usually are numerical values that are health- or risk-based values or methodologies. They establish acceptable amounts or concentration of chemicals that may be found in, or discharged to, the ambient environment. They also may define acceptable exposure levels for a specific contaminant in an environmental medium. They may be actual concentration-based cleanup levels, or they may provide the basis for calculating such levels. Examples of chemical-specific ARARs are PCB cleanup criteria for soils under TSCA.

Location-specific ARARs are design requirements or activity restrictions based on the geographical or physical positions of the site and its surrounding area. Location-specific requirements set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location. Examples include areas in a floodplain, a wetland, or a historic site. Location-specific criteria can generally be established early in the RI/FS process since they are not affected by the type of contaminant or the type of remedial action implemented.

Action-specific ARARs are technology-based, establishing performance, design, or other similar action-specific controls or regulations for the activities related to the management of hazardous substances or pollutants. Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs, which specify performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. An example includes transportation of hazardous waste regulations.

Additionally, TBC criteria are also evaluated. TBC criteria are not federally enforceable standards but may be technically or otherwise appropriate to consider in developing site- or media-specific PRGs. Each of these groups of ARARs and TBCs is described below.

2.2.2 Chemical-specific ARARs and TBCs

Chemical-specific ARARs are health-based or technology-based numerical values that establish concentration or discharge limits for specific chemicals or classes of chemicals. If more than one requirement applies to a contaminant, compliance with the more stringent applicable ARAR is required. In the absence of ARARs and TBC criteria, guidance values are considered. **Table 2-1** includes a brief synopsis of the requirement that each identified ARAR entails, the status of each ARAR (i.e., whether the ARAR is applicable, relevant, appropriate) or TBC, and a brief discussion of the ARAR's considering in this FS.

2.2.3 Location-Specific ARARs

Location-specific ARARs are those that are applicable or relevant and appropriate due to the location of the site or area to be remediated. The site is not located within wetlands or floodplain areas, and the site has no wildlife habitat area. Possible applicable regulations at the site are historical places, archaeological significance, and endangered species.

Based on historical imagery, the site and vicinity was undeveloped in 1900, and by 1947, the site and surrounding areas to the north, south, and west had been developed with structures. A cultural resources survey/archeological evaluation (i.e., archival investigation/walkthrough at the property) to determine if archeological or historical resources are present at the site has not been conducted to date.

The ecological risk assessment noted there was no viable habitat at the site except for animals capable of surviving in an urban habitat (e.g., rodents, raccoons, bats, birds).

Table 2-2 outlines the location-specific criteria applicable to the site.

2.2.4 Action-specific ARARs and TBCs

Action-specific ARARs are requirements that set controls and restrictions to particular remedial actions, technologies, or process options. These regulations do not define site cleanup levels but do affect the implementation of specific remedial technologies. For example, although outdoor air has not been identified in the RI report as a contaminated medium of concern, air quality ARARs are listed as ARARs because some potential remedial actions may result in temporary inhalation hazards due to toxic or hazardous substances caused by dust particles in air. Another example is that the treatment, storage, and disposal of waste would need to meet the requirements of Land Disposal Restrictions (LDRs) under the Resource Conservation and Recovery Act (RCRA). These action-specific ARARs are considered in the screening and evaluation of various technologies and process options in subsequent sections of this report. **Table 2-3** outlines the action-specific criteria applicable to the site.

2.2.5 Mixed Waste Management

Mixed waste is waste that contains a hazardous waste component and a radioactive material component. The site soil contained Technologically Enhanced Naturally Occurring Radioactive

Material (TENORM) resulted from processing the monazite sand that has concentrated the radioactivity or increased the likelihood of exposure by making the radioactive material more accessible to human contact. The presence of benzo(a) pyrene, which has a waste code of U022, in site soils may mean some of those soils could be considered hazardous which would create a mixed waste.

Mixed waste is usually jointly regulated under both RCRA and the Atomic Energy Act (AEA). RCRA regulates the hazardous waste portion of the waste as any other hazardous waste, while the AEA regulates the RCRA-exempt radioactive portion (52 FR 15939; May 1, 1987). However, the low-level mixed waste (LLMW) and technologically enhanced naturally occurring and/or accelerator-produced radioactive material (NARM) are exempt from RCRA Subtitle C requirements, including permitting, provided they meet specific conditions. The exempt wastes must be managed as radioactive waste according to NRC regulations.

2.2.6 PCB and PCB/Radioactive Combined Waste Management under TSCA and NYSDEC Remedial Programs

TSCA provides federal PCB remediation policy. The TSCA regulations dealing with the remediation of soil as "bulk remediation waste" are primarily found in 40 CFR 761.61(a - c). TSCA does not regulate PCBs at concentrations less than 1 part per million (ppm). Above 1 ppm PCBs, TSCA stipulates a range of cleanup levels based upon high and low occupancy scenarios that are identified in 40 CFR 761.61(a)4:

- High Occupancy Areas (average more than 6.7 hours/week for exposure to soil) – The cleanup level for bulk PCB remediation waste in high occupancy areas is ≤1 ppm without further conditions. High occupancy areas where bulk PCB remediation waste remains at concentrations >1 and ≤10 ppm shall be covered with a cap (a minimum of 10 inches of soil).
- Low Occupancy Areas (average less than 6.7 hours/week for exposure to soil) – The cleanup level for bulk PCB remediation waste in low occupancy areas is ≤25 ppm unless otherwise specified. Bulk PCB remediation wastes may remain at a cleanup site at concentrations >25 and ≤100 ppm if the site is covered with a cap.

New York Environmental Remediation Programs (6 New York Codes, Rules, and Regulations [NYCRR] Part 375) specifies soil clean-up objectives of 0.1 ppm for unrestricted use, 1ppm for restricted use (residential and commercial) and 25 ppm for restricted industrial use.

PCB remediation wastes must be disposed of using one (or a combination, if appropriate) of the approved disposal options. Non-liquid cleanup waste (e.g., non-liquid cleaning materials, personal equipment) at any concentration and bulk PCB remediation wastes at concentrations <50 ppm may be disposed of at an approved PCB disposal facility; or when disposed pursuant to Section 761 .61(a) or (c), a permitted municipal solid waste or non-municipal non-hazardous waste facility; or a RCRA Section 3004 or Section 3006 permitted hazardous waste landfill. Bulk PCB remediation waste at concentrations ≥50 ppm must be disposed of in a RCRA Section 3004 or 3006 permitted hazardous waste landfill or an approved PCB disposal facility (e.g., incinerator, chemical waste landfill; via an approved alternate disposal method (EPA 2005).

Some onsite soil contains both elevated levels of PCBs, BAP, and radionuclides including Th-232 and Ra-226. Three Aroclor 1260 detections (1,200 µg/kg, 3000 µg/kg, and 100,000 µg/kg) exceeded the RI screening criterion (240 µg/kg). The PCB/radioactive combined contaminated soil can be managed and disposed of in a low level radioactive waste disposal facility, provided that certain conditions are met as illustrated in the table below.

PCB Remediation Waste Category	Definition	Acceptable[1]
Non-liquid Cleaning Materials and PPE	Includes non-porous surface and other non-liquid materials such as rags, gloves, booties, other disposable PPE, and similar materials resulting from PCB cleanup activities	Yes
<50 ppm or <100 µg/100 cm²	PCB remediation waste containing <50 ppm or <100 µg/100 cm²	
≥50 ppm or ≥100 µg/100 cm²	PCB remediation waste containing ≥50 ppm or ≥100 µg/100 cm²	Yes[2]

[1]Table copied from Energy*Solutions* "Bulk Waste Disposal and Treatment Facilities Waste Acceptance Criteria, Revision 7"

[2]Requires disposal in Energy*Solutions*' Mixed Waste disposal embankment.

2.2.7 Principal Threat Waste

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (40 CFR 300.430(a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. Although no "threshold level" of toxicity/risk has been established to equate to principal threat, the EPA guidance document on principal threat wastes (EPA 1991) recommends that when toxicity and mobility of source material combine to pose a potential risk of 10^{-3}, or greater, generally treatment alternatives should be evaluated. The contaminated soil within and some areas outside of the WACC property contains process tailings and other solid process wastes resulting from processing the monazite sand that has concentrated the radioactivity or increased the likelihood of exposure by making the radioactive material more accessible to human contact. As a result, the contaminated soil and sediments/sludge in the sewer line pose high risks ($>1x10^{-3}$) to human health and are therefore considered principal threat waste (PTW).

Where EPA determines that it is not practicable to use treatment to address principal threat waste, such waste may be transported off-site, consistent with the Off-Site Disposal Rule (40 CFR 300.440) or managed safely on-site, consistent with ARARs identified for the site.

2.3 Preliminary Remediation Goals

PRGs are developed for the list of COCs identified in Section 2.1.1.3 to aid in defining the extent of contaminated media requiring remedial action. PRGs are generally radionuclide-specific and chemical-specific remediation goals for each medium and/or exposure route that are established to protect human health and the environment. They can be derived from ARARs, risk-based levels (human health and ecological), and from comparison to background concentrations, where available. Consideration can also be given to analytical detection limits, guidance values, and other pertinent information. Development of PRGs for the site is presented below.

Th-232, Ra-226, radon (indoor air), and thoron (indoor air) were identified as the radionuclide risk drivers in the HHRA while benzo(a)pyrene and Aroclor 1260 were identified as the chemical risk drivers.

For the WACC site, identification of PRGs for the risk drivers included a consideration of background values, risk-based concentrations and ARARs and TBCs, including NYSDEC Subpart 375-6: Table 375-6.8(b): Unrestricted Use Soil Cleanup Objectives (residential use), 40 CFR Part 192, Memorandum providing updated guidance on "Radiation Risk Assessment at CERCLA Sites: Q & A" (EPA 2014), and A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon (EPA 2012b).

Radionuclides PRGs were calculated using the EPA PRG calculator to be consistent with EPA policy and to reflect likely future site conditions. Calculation of PRGs for the FS involved evaluation of calculator input. Specifically, site specific input parameters for area (5000 square meters [m^2] for site area of approximately 1 acre) and shielding factor of 0.2 in lieu of the 0.4 default were used to calculate protective PRGs for the site (EPA 1996). PRGs estimated by RESRAD, 1 pCi/g for Ra-226 and 4 pCi/g for Th-232, were used as a soil input to the PRG calculator to determine if risks remain below the upper limit of the EPA risk range. Typically, the risk target range is between 1E-06 and 1E-04. However, background concentrations of naturally occurring radionuclides often exceed levels associated with those risk targets. In OSWER 9285.6-20, the EPA has recommended that risks be commensurate with a radiological dose of 12 millirems per year (mrem/yr) or less, which is associated to a risk value of 3E-04. Results of the PRG risk calculations indicated a risk value of 2.77E-04, which is in keeping with that EPA directive. Note that risk values derived for the calculation of PRGs are for concentration of a radionuclide above its naturally occurring background concentration. At the site, the upper range of the background levels based on the 95% UTL for Ra-226 and Th-232 are 0.92 and 1.2 pCi/g, respectively. **Table 2-4** presents the PRGs for the COCs to be addressed in the FS. Additional information regarding the calculations for the Ra-226 and Th-232 PRGs is provided in the Revised Preliminary Remediation Goals for Radium-226 and Thorium-232 Wolff-Alport Site technical memorandum (CDM Smith 2017c) presented in **Appendix B**.

For the FS, RESRAD modeling was conducted to determine air concentrations for the radionuclides of concern (ROCs) based on a 12 millirem/year exposure for consideration in the selection of PRGs for the site. Those results are provided in **Appendix C** and **Table 2-4**.

2.4 Identification of Remediation Target Area

The remediation target area includes portions of the site where site COCs exceed their PRGs. **Figure 2-1** shows the aerial extent of soils exceeding the PRGs and the depth to which soils exceed the PRGs in site borings. The extent of contamination is delineated using the nearest clean sample in the outward direction from the WACC property. When such a sample did not exist, the extent was estimated as 20 feet away from the furthest sample result above PRGs based on general boring spacing or to the next physical barrier (e.g., a building). The depth of contamination was delineated using the sample results in each boring. One exception is the SB-32 soil boring. BAP contamination was found at 7 feet bgs. However, the depth of excavation here is included in the 4 feet bgs excavation because this sample was collected from an obviously mounded area where soils associated with a UST removal were likely stockpiled. Therefore, the 4 feet bgs is to be understood as 4 feet below natural topography rather than the mounded grade. For the purposes of identifying areas of significantly elevated areas of contaminations, hotspots are defined as those areas containing samples with combined Th-232 and Ra-226 concentrations greater than 50 pCi/g. Note that the aerial extent of contamination is not fully defined and the contaminated areas will be refined during the remedial design.

Figure 2-2 shows the portion of the sewer line that will require remediation. From manhole I-1 to I-4, the sewer line would be excavated and disposed offsite based on exceedance of the PRGs. Because the data collected from the sewer are gamma counts (cpm) for the most part, the extent of the remaining portion of sewer line requiring remediation is based on a gamma count of 10,000 cpm, which is considered significantly (three to eight times) above the background levels. The available sample data and locations show that at counts greater than 10,000 cpm, contamination is present with concentrations typically greater than the PRGs. As a result, the 10,000 cpm value provides a starting point for delineating areas that have potentially been impacted and require further investigation. The sewer lines from manhole I-4 to W-1 and from manhole C-1 to I-3 would go through high pressure jet cleaning. Following completion of sewer jet cleaning, a gamma survey would be performed within the flushed sewer to determine if high gamma counts (*i.e.,* above 10,000 cpm) are still present. Any portions of the sewer line where gamma counts are still greater than 10,000 cpm would undergo further investigation, including bedding and sewer material sampling, to determine the level and extent of contamination. Those portions of the sewer line, along with contaminated bedding material that exceed PRGs, would be removed and replaced. Because the bedding material can provide a preferential path for contamination to migrate, it is possible that contamination from an upstream sewer line breach might exist in the bedding underlying intact piping.

Additional figures depicting the extent of Th-232, Ra-226, PCBs, and BAP concentrations (on which **Figures 2-1** and **2-2** are based) are included in **Appendix A**. Based on **Figure 2-1**, the Th-232 and Ra-226 cleanup area encompasses the PCBs and BAP cleanup area. **Appendix D** presents the volume calculations for construction and demolition debris (C&D), contaminated soils, and contamination sewer line waste. The following volumes have been estimated for the FS:

- Sewer Debris: 40 cubic yards (cy)
- Pavement Debris from Sewer Excavation: 200 cy
- Building Debris: (assuming demolition of all WACC buildings):
    - Non-radiological: 2,200 cy
    - Radiological: 2,600 cy
- Soil Associated with Sewer excavation:
    - Non-radiological: 4,400 cy

    - Radiological: 800 cy

- Contaminated Soils above PRGs: 18,000 cy
- Pavement Debris from Soil Excavation: 660 cy

2.5 General Response Actions

GRAs are initial broad remedial actions that may satisfy the RAOs and which characterize the range of remedial responses appropriate for the contaminated media at the site. Following the development of GRAs, one or more remedial technologies and process options are identified for each GRA category. Although an individual response action may alone satisfy the RAOs, combinations of GRAs are usually required to adequately address site contamination. The following sections present the GRAs that may be applicable to address indoor air and soil/solids contamination including soils, sewer sediments/sludge, and building, sewer and pavement C&D debris. at the site and detail the subsequent technology screening process. The technologies and process options remaining after screening will be assembled into alternatives that will be discussed in Section 3.

2.5.1 No Action

The NCP requires the evaluation of a no action/no further action alternative as a basis for comparison with other remedial alternatives. Under the no action response, no remedial actions are implemented, the current status of the site remains unchanged, and no further action would be taken to reduce the potential for exposure to contamination. While the No Action response action may include environmental monitoring to track the contamination, it does not include any actions (e.g., institutional controls) to protect human health or the environment.

2.5.2 Institutional/Engineering Controls

EPA defines institutional controls (ICs) as non-engineered instruments, such as administrative and legal controls (e.g., environmental easement) that help to minimize the potential for exposure to contamination and/or protect the integrity of a response action. ICs typically are designed to work by limiting land and/or resource use or by providing information that helps modify or guide human behavior at a site.

Engineering controls (ECs) are restrictions intended to minimize access (e.g., fencing) or other measures to reduce exposure (e.g., warning signs). These limited measures are implemented to provide some protection of human health and the environment from exposure to site contaminants. ICs/ECs are generally used in conjunction with other remedial technologies; alone, they are not effective in preventing contaminant migration or reducing contamination.

2.5.3 Inspection, Maintenance, and Monitoring

Monitoring activities include activities, such as sampling and analysis, to track the fate and transport of the contaminants (e.g., long-term monitoring). Inspections and maintenance activities are performed to assess and maintain the integrity of a remedy and assess changes in site conditions that pose risks of exposure. These measures do not alter the location or concentrations of contaminants, but they assist in delineating the nature and extent of contamination over time. Hence, they are generally used in conjunction with other GRAs and are not effective alone in achieving the RAOs for the contaminants by themselves.

2.5.4 Containment

Containment technologies consist of actions that physically isolate contaminants from their potential receptors by eliminating routes of exposure or reducing the rate of migration. Containment technologies may reduce contaminant movement but do not involve treatment to reduce the toxicity, mobility, and volume of the contaminants at the site. These technologies will require long-term monitoring and inspection to determine whether containment measures are performing successfully. These technologies will also require some type of IC to ensure the integrity of the containment remedy over the long term. These measures will not permanently and significantly reduce the toxicity and volume of contaminants without treatment.

2.5.5 Removal

Removal response actions refer to methods typically used to excavate and handle soil, sediment, waste, and/or solid materials. Removal response actions also include demolition technologies to dismantle and remove building materials. Excavation and demolition technologies provide no treatment of wastes but may be used prior to treatment or disposal to remove wastes from designated areas. They transfer the contaminants to be managed under another response action and/or allow access to contaminated media to be addressed. Hence, removal technologies would be considered in conjunction with technologies for treatment and disposal response actions.

2.5.6 Disposal

Disposal technologies for soil, waste, or water typically include onsite or offsite disposal to a facility permitted for the specific waste type. Pretreatment of the material may be necessary before an offsite facility will accept the waste or to meet RCRA LDRs before disposal. These measures will not permanently and significantly reduce the toxicity or volume of contaminants without treatment. As noted in Section 2.2.5, LLMW, TENORM, and NARM are exempt from RCRA Subtitle C requirements, including permitting, provided that they meet specific conditions and must be managed as radioactive waste according to NRC regulations.

The material at the site is considered TENORM material and, depending on the concentration of the thorium and radium, portions of the waste will need to be disposed of in a low level radioactive waste landfill. In cases where radionuclide concentrations are less than 50 pCi/g, there are some states that will allow disposal in a Class D landfill. In all cases, the Waste Acceptance Criteria (WAC) for each facility will need to be evaluated prior to determining if the landfill can accept the material from the site for disposal. If the wastes do contain a RCRA component, some sites such as the Energy Solutions facility in Clive Utah, are permitted to perform certain treatments to allow landfill disposal. If the planned landfill facility cannot perform the treatment, it will be necessary to contract with a facility to treat the waste prior to shipment and disposal at a permitted landfill or low level radioactive waste disposal facility.

Nonradioactive bulk PCB remediation waste at concentrations ≥50 ppm must be disposed of in a RCRA Section 3004 or 3006 permitted hazardous waste landfill or an approved PCB disposal facility (e.g., incinerator, chemical waste landfill; via an approved alternate disposal method (EPA

2005). PCB/radioactive combined contaminated soil can be managed and disposed of in a low level radioactive waste disposal facility.

2.5.7 Treatment

Treatment involves the destruction of contaminants in the affected media, transfer of contaminants from one medium to another, or transformation of the contaminants to a less mobile form, resulting in the permanent and significant reduction of the T/M/V of the contaminants and achieving a higher degree of protection of human health and the environment. Treatment technologies vary among environmental media and contaminants and may consist of chemical, physical, thermal, and/or biological processes. Treatment can be implemented either in situ or ex situ. The use of treatment technologies to achieve RAOs is favored by CERCLA, unless site conditions limit their application.

2.6 Identification and Screening of Remedial Technologies and Process Options

Remedial technology types and process options that are capable of addressing radionuclide, Aroclor 1260, and BAP contaminated materials are identified and organized under each GRA listed in the previous section.

For each GRA, various remedial technologies and their associated process options are considered for the response action. The term technology refers to general categories of remediation methods. Each technology may have several process options, which refer to the specific material, equipment, or method used to implement a technology. These technologies describe broad categories used in remedial action alternatives but do not address details, such as performance data, associated with specific process options.

The preliminary technology/process option screening is typically very broad in considering the suitability of a technology for addressing contaminated materials. To streamline the process, EPA guidance documents (Technology Reference Guidance for Radioactively Contaminated Media, EPA/402/R-07/004, EPA 2007; Guidance on Remedial Actions for Superfund Sites with PCB Contamination, EPA/540/G-90/007, EPA 1990; and Technology Alternatives for the Remediation of PCB Contaminated Soils and Sediments, PCB-EPA_600-S-13-079, EPA 2013c) were used to identify and evaluate technologies for the remediation of contaminated soil and building materials. Only the treatment and disposal technologies that are determined to be effective and implementable for treatment of contaminated soils and sewer sediments in these two guidance documents will be considered in this FS report. The identification of technologies from these guidance documents serves as a screen for technical implementability. Potentially viable remedial technologies and associated process options identified for the contaminated materials are presented in **Figure 2-3**.

Specific technology types and process options under each GRA category were then evaluated against the three criteria: effectiveness, implementability, and relative cost, specified in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988). Among these three criteria, the effectiveness criterion outweighs the implementability and relative cost criteria. Brief definitions of the criteria, as they apply to the screening process, are provided below.

Effectiveness: This evaluation criterion focuses on the effectiveness of process options to provide long-term protection and to meet the RAOs and PRGs. It also evaluates the potential impacts to human health and the environment during construction and implementation and considers how proven and reliable the process is with respect to site-specific conditions. Technologies and process options that are not effective are eliminated using this criterion.

Implementability: This evaluation criterion encompasses both the technical and administrative feasibility of the technology or process option. It includes an evaluation of pretreatment requirements, remedial construction requirements, residuals management, the relative ease or difficulty of operation and maintenance (O&M), the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology. Technologies and process options that are clearly not implementable at the site are eliminated using this criterion.

Relative Cost: Relative cost plays a limited role in the screening process. Both relative capital and relative O&M costs are considered. The relative cost analysis is based on engineering judgment, and each process is evaluated as to whether costs are low, medium, or high relative to the other options within the same GRA category.

Based on the three evaluation criteria described, technologies and process options were screened from further consideration. Documentation of the identification and screening process is provided below.

Only those technologies and process options that have been retained are considered for the development of alternatives. The retained technologies and process options are those that are expected to achieve the remedial action objectives for the site, either alone or in combination with other technologies and process options. Combinations of these technologies and process options are considered to constitute the reasonable alternatives required by the NCP.

2.6.1 No Further Action

The No Further Action alternative is developed from this GRA, as required by the NCP, and evaluated to establish a baseline for comparison with other remedial alternatives. In 2013, EPA conducted radiation mitigation activities by installing fencing at the site and shielding portions of the radioactive soil with rock and clean fill to reduce accessibility to the waste material. Additional shielding consisting of lead, steel, and concrete was installed within several structures at the WACC property and along a portion of the Irving Avenue sidewalk. A radon mitigation system was also installed within one building.

Since action has already been taken at this site, under this alternative, no further action would be taken to remediate or monitor contamination at the site to address the associated risks to human health. This also includes no maintenance of the radon mitigation system currently in place.

Because this alternative would result in contaminants remaining above levels that allow for unrestricted use and unlimited exposure, five-year reviews would be conducted for the site to assess the performance and protectiveness of the remedy. If necessary, appropriate action would be considered at that time.

Effectiveness – The No Further Action alternative would not be effective in terms of protecting human health from contaminants in soil. With the shielding and radon mitigation systems in place, there still exist risks to human health above EPA's threshold. This alternative would not be in compliance with chemical-specific ARARS, nor would it meet RAOs, alter the location of contaminants or reduce T/M/V of contaminants through treatment. Because no further action would be taken, long-term effectiveness and permanence criteria would not be met.

Implementability – No Further Action is easy to implement from a technical perspective, and no significant administrative difficulties are expected.

Relative Cost – There is no cost for this response action.

Conclusion – No Further Action is retained as a baseline for comparison to other alternatives, as required by the NCP.

2.6.2 Institutional/Engineering Controls

ICs are non-engineered instruments, such as administrative and/or legal controls, that minimize the potential for human exposure to contamination by limiting land or resource use. ICs are generally used in conjunction with engineering measures, such as waste treatment or containment and can be used during all stages of the cleanup process, to accomplish various cleanup-related objectives. There are four categories of ICs: proprietary controls, governmental controls, enforcement and permit tools, and informational devices.

- Proprietary Controls: These controls include easements and covenants and are created pursuant to state and tribal laws to prohibit activities that may compromise the effectiveness of the response action or to restrict activities or future resource use that may result in unacceptable risk to human health or the environment.
- Governmental Controls: These controls use the authority of a government entity to impose restrictions on land or resource use. Types of governmental controls include zoning, building codes, groundwater use regulations, and commercial fishing bans and fishing limits.
- Enforcement and Permit Tools with Institutional Control Components: These are legal tools, such as administrative orders and permits that limit site activities or require certain site activities.
- Informational Devices: Informational devices provide information or notification, often as recorded notice in property records or as advisories to local communities, tourists, recreational users, or other interested persons, that residual contamination remains on the site. As such, informational devices generally do not provide enforceable restrictions. Typical informational devices include state registries of contaminated sites, notices in deeds, tracking systems, and fish/shellfish consumption advisories.

In addition, community information and education programs would be undertaken to enhance awareness of potential hazards and remediation processes to the local community.

ECs could restrict access to the site with fencing and signs to prohibit access to areas that could disturb the selected remedy after it has been installed or pose a risk to human health.

Effectiveness – ICs/ECs could effectively restrict or eliminate exposure to contaminated soil, thereby reducing human health risks. The effectiveness of ICs/ECs would depend on proper enforcement. ICs/ECs would not reduce the environmental impact of the contaminants' migration from soils in contaminated areas.

Implementability – IC implementability would highly depend on the local government and its enforcement system. There should be no difficulties with implementation of ECs.

Relative Cost – The implementation cost is low. Some administrative, long-term inspection and periodic assessment costs would be required.

Conclusion – ICs/ECs are retained for further evaluation.

2.6.3 Inspection, Maintenance, and Monitoring

An inspection, maintenance, and monitoring program includes inspection of engineering control systems such as a radon mitigation system, performance of repairs, as necessary, and collection of samples from contaminated media to monitor contaminant concentrations such as radon measurements. Monitoring is a proven and reliable process for tracking the migration of contamination during and after response actions are completed. Therefore, inspection, maintenance, and monitoring would not be implemented as a standalone response action but would be used in conjunction with other proposed alternatives to evaluate and monitor remediation progress. Monitoring activities can occur during the construction phase of work as well as part of post-construction operation and maintenance as a long-term monitoring program. Monitoring as part of a long-term monitoring program would continue until contamination is no longer present either having been treated by a remedial action or through natural attenuation.

Effectiveness – Inspection, maintenance, and monitoring alone would not be effective in reducing contamination levels. It would not alter the risk to human health or the effect on the environment. However, regular inspection would be effective in providing information onsite conditions to decision makers.

Implementability – Inspection, maintenance, and monitoring are proven, reliable processes and can be easily implemented. However, the reliability of long-term implementation relies on resource availability. For the site, long-term monitoring would continue indefinitely if radioactive contamination is left in place as contamination would not be treated or transformed to less radioactive materials due to the very long half-life of Th-232.

Relative Cost – Low capital and medium O&M costs.

Conclusion – Retained for further consideration.

2.6.4 Containment

This process option is for contaminated media left in place (with or without excavation and consolidation) above the PRGs. Containment technologies provide barriers between contaminated media to prevent contaminant migration and shield potential receptors from radiation. Containment process options include capping, and cryogenic barriers.

2.6.4.1 Capping

The cap would be appropriately designed to reduce gamma radiation exposure to site workers and the public and could consist of lead, steel, concrete, and/or soil. It is assumed that the WACC buildings' foundation has footings to approximately 24 to 30 inches bgs. Because contamination extends much deeper than 24 to 30 inches bgs, a cap would be applied over the slab foundation of the buildings to provide shielding.

<u>Effectiveness</u> – Construction of a cap protects receptors by eliminating gamma exposure of contaminants. Gamma radiation surveys conducted before and after the response action in which shielding was installed at the Site showed a significant decrease in gamma radiation (Weston 2016) from shielded contaminated soils, proving that a cap would be effective at the site. A cap would also prevent contaminated soil erosion and transport by air and water.

<u>Implementability</u> – Capping can be implemented using available construction resources and materials. It may need to be combined with institutional and engineered controls and will require maintenance for long-term protectiveness.

<u>Relative Cost</u> – Moderate to high capital cost and low O&M cost.

<u>Conclusion</u> – Retained for further consideration.

2.6.4.2 Cryogenic Barriers

Cryogenic barriers freeze contaminated subsurface soils to create an ice barrier around a contaminated zone. This reduces the mobility of the contaminants (radionuclides and chemicals) by confining the materials. The refrigeration unit would require continuous operation and maintenance until the radionuclides no longer emit gamma particles to prevent barrier thaw.

The proximity of engineered structures such as roads, building foundations, piping, and utilities should be taken into account since high frost heave pressures can develop.

<u>Effectiveness</u> – The cryogenic barrier would not be effective at reducing gamma radiation exposure from radionuclide contamination. It would reduce the mobility of the PCBs and BAP but would not treat the toxicity or volume.

<u>Implementability</u> – Due to the urban vicinity of the site and nearby underground utilities, this technology would be difficult to implement.

<u>Relative Cost</u> – High capital and O&M costs.

<u>Conclusion</u> – Not retained for further consideration due to implementability issues and lack of effectiveness.

2.6.5 Removal

2.6.5.1 Excavation

Removal (excavation) is generally implemented with treatment or disposal technologies. Excavation can be performed manually or by mechanical means. In general, heavy machinery is utilized for mechanical removal of large quantities of soil, waste, or sediment. A variety of equipment, such as hydraulic excavators, backhoes, and front-end loaders, can be used to perform excavation activities. Manual excavation is only useful for removal of small amounts of soil or when heavy machinery cannot be used in certain areas that are hard to access or where structural integrity is uncertain.

To aid in developing and evaluating remedial alternatives for the site, a structural inspection of the WACC buildings was completed on February 17, 2017 to determine feasibility of excavation below the building after removal of the building slab. The inspection concluded that a reasonable assumption for the FS alternative development is that depth of footing is 24 inches to 30 inches below grade since the building at Lot 33 occurs at that elevation. However, any alternative that includes soil excavation below the buildings will need footing size and elevations verified by coring/selective excavation or ground penetrating radar. Therefore, for the purposes of this FS, excavation below any buildings at the WACC property while the buildings are standing is not considered. The structural inspection report is presented in **Appendix E**.

Excavation of contamination at the WACC site would require demolition of the WACC property buildings and the streets (e.g., Irving Avenue and Moffat Street) near the WACC property. Active businesses located in the WACC property buildings would need to be relocated.

<u>Effectiveness</u> – Excavation could result in increased contaminant exposure potential to workers and community during construction. Reduces risk to receptors by minimizing future exposure to contaminated materials and migration of contaminants. Must be combined with containment, transport, disposal, and/or treatment technologies.

<u>Implementability</u> – After demolition of buildings, excavation can be easily implemented with standard earth moving equipment and/or hand tools. Radiation exposure and air monitoring also will be required.

<u>Relative Cost</u> – Moderate to high capital costs.

<u>Conclusion</u> – Retained for further consideration.

2.6.5.2 Sewer Jet Cleaning

Sewer jet cleaning uses high-pressure water nozzles to flush out dirt, sediments/sludge, and any other matter from sewer pipelines. This is usually used in combination with vacuuming to collect the waste for disposal.

<u>Effectiveness</u> – Sewer jet cleaning would be effective at removing the contaminated sediment and sludge from the impacted CSS along Irving Avenue. However, a sewer cleaned in this way may have residual contamination on or within cracks and crevices in the pipe wall since it was not specifically designed for radioactive decontamination of construction materials. Additionally,

sewer jetting would not remove radionuclide contamination in the sewer construction materials (i.e., cast iron, brick, and concrete) found in the CSS along Irving Avenue.

Implementability – Sewer jet cleaning can be easily implemented with sewer cleaning machines. Vendors are readily available. Radiation exposure and air monitoring also will be required.

Relative Cost – Low capital costs.

Conclusion – Sewer jet cleaning is retained for further consideration.

2.6.5.3 Demolition

Demolition refers to an operation in which a structure or mass of material is wrecked, razed, rendered, moved, or removed using any tool, equipment or explosives. Explosives are used to achieve demolition via implosion. Mechanical means of demolition include use of a crane and ball or high reach arm consisting of a primary tool such as shears, crushers or hammers, attached to a base machine such as an excavator, Demolition of structures is generally implemented in conjunction with disposal technologies.

Effectiveness – Demolition could result in increased contaminant exposure potential to workers and community during construction. Reduces risk to receptors by minimizing future exposure to contaminated materials. Must be combined with containment, transport, disposal, and/or treatment technologies.

Implementability – Prior to demolition, pre-demolition activities such as asbestos abatement, lead-based paint management, universal waste removal, non-structural component removal, utility abandonment, establishment of dust control measures, establishment of water management measures (for dust suppression and surface runoff), and establishment of stockpile locations would need to be completed. Radiation exposure and air monitoring would be required during demolition activities.

Relative Cost – Low to moderate capital costs.

Conclusion – Retained for further consideration.

2.6.6 Landfill Disposal

Landfill disposal is one of the most common methods for disposal of radioactive material. Landfill disposal is used to cover waste materials to prevent contact with the environment and to effectively manage the human and ecological risks associated with those wastes. Since treatment of radioactive wastes currently does not exist, landfill disposal costs are those of transportation and disposal rather than treatment. The radioactive waste at the Site would be disposed of as TENORM.

Legal authority for the management of the TENORM wastes on the basis of radiological concerns impacting human health or the environment rests with individual states. There is a uniform agreement among states for an exempt activity level below 5 pCi/g for combined Ra-226 and Ra-228 (Michigan Department of Environmental Quality 2015). Standards for the management of TENORM wastes above 5 pCi/g varies widely amongst states, both in scope and specificity. For example, waste containing 50 pCi/g of Ra-226 can be disposed in any Type I (i.e., hazardous waste) or Type II (i.e., municipal solid waste) landfill in Michigan (Michigan Department of Environmental Quality 2015). Note that for the site, the radionuclides of concern are Th-232 and Ra-226.

Offsite landfills are commercially owned, permitted facilities that minimize potential environmental impacts of disposal waste. Landfilling is considered a non-treatment alternative and less acceptable than treatment alternatives according to CERCLA. The final determination on whether the material is hazardous or non-hazardous would be based on its Toxicity Characteristic Leaching Procedure results. The maximum concentrations of arsenic and selenium to be characterized as toxic are 5 mg/L and 1 mg/L, respectively. Using the 20-fold dilution factor rule-of-thumb, arsenic concentrations greater than 100 mg/kg and selenium concentrations greater than 20 mg/kg might be characterized as toxic in a TCLP test. The maximum concentration of arsenic observed during the RI was 31 mg/kg; therefore, arsenic is not expected to be a concern. Selenium concentrations greater than 20 mg/kg were observed in two soil samples at 1,100 mg/kg and 50 mg/kg. Soil at these two locations could potentially be classified as characteristic waste (D010). Regardless, these soils would still go to the same landfill as those for radioactive soils since the radioactivity in the soils would drive disposal options.

As noted in Section 2.2.6, PCB remediation wastes must be disposed of using one (or a combination, if appropriate) of approved disposal options. Non-liquid cleanup waste at any concentration and bulk PCB remediation wastes at concentrations <50 ppm may be disposed of at an approved PCB disposal facility; or when disposed pursuant to Section 761 .61(a) or (c), a permitted municipal solid waste or non-municipal non-hazardous waste facility; or a RCRA Section 3004 or Section 3006 permitted hazardous waste landfill. Bulk PCB remediation waste at concentrations ≥50 ppm must be disposed of in a RCRA Section 3004 or 3006 permitted hazardous waste landfill or an approved PCB disposal facility (EPA 2005). PCB/radioactive combined contaminated soil can be managed and disposed of in a low-level radioactive waste disposal facility, provided certain conditions are met.

<u>Effectiveness</u> – Offsite landfill disposal will prevent direct contact risk to receptors; however, landfill disposal of contaminated soil and building materials does not provide waste reduction or destruction, only containment. Persistent substances like radionuclide and PCB wastes will remain in landfills for long periods of time with little degradation.

<u>Implementability</u> – Landfill disposal is implementable as there are landfills to accept the radioactive waste at the varying contaminant levels.

<u>Relative Cost</u> – High capital costs/negligible O&M costs.

<u>Conclusion</u> – Retained for further consideration.

2.6.7 Treatment

2.6.7.1 Incineration

Some radionuclide-contaminated soil at the site is mixed with high concentrations of BAP and Aroclor 1260. Incineration of the chemically hazardous and radioactive soils can reduce the total volume and the total chemical toxicity of the soils. Incineration does not, however, reduce the radioactivity of the incinerated materials.

Incineration treats PCB contaminated solids by subjecting them to temperatures typically greater than 760°C (1,400°F) in the presence of oxygen, which causes volatilization, combustion, and destruction of the compounds (EPA 2013c). Incinerators must be designed and operated to meet the 99.9999 percent Destruction and Removal Efficiency required for PCBs (EPA 2013c). However, TSCA does not require incineration of PCB-contaminated soil or building materials prior to disposal.

Radioactive waste incinerators, when equipped with well-maintained, high efficiency filters, can capture all but a small fraction of the radionuclides fed into them. The fraction that does escape, however, tends to be in the form of small particles that are more readily absorbed by living organisms than larger particles.

Effectiveness – Incineration would not reduce the radioactivity of the contaminated materials. PCB-contaminated soil does not require incineration prior to disposal.

Implementability – There was an operating DOE mixed waste incinerator located in Oak Ridge, Tennessee (Institute for Energy and Environmental Research 2000); however, it was shut down in 2009 for formal closure (https://energy.gov/orem/articles/incinerator-completes-mission-oak-ridge)

Relative Cost – Very high capital/high O&M costs.

Conclusion – Incineration is not retained for further evaluation due to lack of effectiveness and implementability.

2.6.7.2 Thermal Desorption

Thermal desorption, which can be implemented either in situ or ex situ, physically separates organic compounds, including Aroclor 1260 and BAP, from soils by heating the contaminated soils at a temperature high enough to volatilize the organic compounds. A vacuum is applied simultaneously to capture the contaminant vapor. Based on the operating temperature, thermal desorption processes are categorized into two groups: high temperature thermal desorption (HTTD), in which wastes are heated to 316 degrees Celsius (°C) (600 degrees Fahrenheit [°F]) to 538°C (1,000°F); and low temperature thermal desorption (LTTD), in which wastes are heated to 93°C (200°F) to 316°C (600°F) (EPA 2013c). Site contaminants, Aroclor 1260 and BAP, would require HTTD. The high temperatures may reduce the water solubility of the radionuclides but would not physical separate the radionuclides from the media.

Effectiveness – Although ex situ thermal desorption can be used to treat the PCBs and BAP prior to disposal and this technology has been selected as the remedial action for at least 16 Superfund sites with PCB-contaminated soils or sediments (EPA 2013c), it is not effective in separating radionuclides from the media, and thoron and radon gas release would also be a concern.

Implementability – This technology has been used since the early 1990s so it is implementable. During the thermal desorption of PCBs, dioxin/furan formation may occur, which needs to be monitored and properly handled. There may be resistance from the public for onsite thermal treatment.

Relative Cost – High capital costs (no O&M cost after the PRG is achieved).

<u>Conclusion</u> – Thermal desorption is not retained for consideration due to its lack of effectiveness in treating radionuclide contamination.

2.6.7.3 Physical Separation Technologies

Physical separation technologies include dry soil separation, soil washing, flotation, and scabbling of contaminated building surfaces. They are a class of treatment in which radionuclide contaminated media are separated into clean and contaminated fractions by taking advantage of the principle that radionuclides are associated with fractions of soil that can be separated based on size, or in the case of building materials, are present at the surface. Therefore, physical separation technologies would only be useful for sites in which the radioactive contamination resides in a certain particle size fraction. Additionally, this technology only reduces the volume of contaminated media requiring treatment and/or disposal but does not treat the contamination.

Dry soil separation involves screening and sieving soils ex situ to separate fines such as silts and clays from coarser fractions of soil. This would concentrate the contaminants into a smaller volume of soil.

Soil washing is an ex situ, water-based remedial technology that mechanically mixes, washes, and rinses soil to remove contaminants. Soil washing is most effective when the contaminated soil consists of little silt and clay and mostly sand and gravel. When soil particles are too small, soil washing performance is poor because these particles are very difficult to separate into contaminated and uncontaminated components (EPA 2007).

Flotation separates fine soil particles from large soil particles by pretreating contaminated soil to remove coarse material and mixed with water to form a slurry to which a flotation agent is added. Air bubbles are passed through the slurry and adhere to floating particles, transporting them to the surface to produce a foam containing the fine soil particles. Then this form is skimmed from the surface. The clean, larger particle soil would then require dewatering and drying to be used as fill.

Scabbling is an abrasive surface layer removal technique that removes the uppermost radioactively contaminated surface layers of concrete structural members. After completion, two waste streams result: (1) the highly-contaminated dust removed during scabbling, and (2) the resulting “clean” base structure.

<u>Effectiveness</u> – Dry soil separation could be effective at the site, assuming that the radionuclide contamination is associated with silts and clays present in the subsurface. Soil washing has not been fully demonstrated as a technology for reducing the volume of radionuclide-contaminated soil (EPA 2007). Also, this would not treat the PCBs and BAP present as they are hydrophobic contaminants, which can be difficult to separate from soil particles into the aqueous washing fluid. The effectiveness of separating radionuclide-contaminated fines from soil using flotation requires more research (EPA 2007).

Scabbling of building materials could result in the generation and discharge of many airborne contaminants including radionuclides, lead, cadmium, chromium, or PCBs from painted or coated surfaces which originally contained these compounds. Scabbling would also generate conventional particulate matter airborne contamination. Since scabbling is embedded in the construction materials and scabbling would only address the surface of the materials, it would not be effective at treating the embedded contamination.

Implementability – Physical separation technologies are not implementable at the site due to the limited space available for the separation equipment, other equipment needed during the process such as cranes and loaders, and a staging area for the separated soils.

To prevent the uncontrolled release of radioactive dust, scabbling would need to be performed in a negative pressure enclosure with exhaust air being appropriately filtered to remove the dust prior to discharge from the workspace. Adherence to air emissions regulations would be required.

Relative Cost – High capital/moderate O&M costs (no O&M cost after the PRG is achieved).

Conclusion – Soil washing does not destroy radionuclides, PCBs, or BAP. Based on its limited effectiveness in separating PCBs from soil particles and its limited use at other PCB Superfund sites, soil washing is eliminated from further consideration. Scabbling is also eliminated from further consideration due to its lack of effectiveness at treating contamination embedded in building materials.

2.6.7.4 Solvent/Chemical Extraction

Solvent/chemical extraction is an ex situ chemical separation technology that separates hazardous contaminants from soils, sludges, and sediments to reduce the volume of hazardous waste that must be treated. The process is completed under controlled pressure and temperature conditions. Solvent extraction is different from soil washing in that it uses an extracting chemical instead of water containing additives to separate out contaminants.

Solvent/chemical extraction involves excavating and transferring soil to equipment that mixes the soil with the solvent/chemical. Solvent/chemical extraction equipment can handle contaminated soil either in batches, for dry soil, or as continuous flow, for pumpable waste. Solvent extraction consists of four basic steps: extraction, separation, desorption, and solvent recovery. Residual solids are processed with additional solvent washes until cleanup goals are met. The extract from this process contains concentrated contaminants into a smaller volume, which would require further treatment such as incineration, dehalogenation, and/or thermal desorption. The treated solids may need to be dewatered, which generates both a dry solid and a water stream, both of which would need to be analyzed and potentially further treated due to the presence of solvent.

Solvents that could be used to remove radioactive waste include: complexing agents, such as ethylenediamine-tetraacetic acid); inorganic salts; organic solvents; and mineral acids, as sulfuric, hydrochloric, or nitric acid (EPA 2007). A broad range of inorganic salt solutions can be used to remove thorium and radium from mill tailings and soils (Devgun et al. 1993).

Chemical extraction processes are available to extract U, Th, and Ra; however, the processes are complicated and expensive and require a threshold level of the radionuclide to be economical. It is unlikely that the levels present in WACC soils and solids, including process waste, make it suitable for reclamation.

Effectiveness – A field demonstration project involving treatment of 1,000 tons of soil contaminated with Ra-226 and Th-232 showed removals of 60 to 67 percent and 73 to 76 percent, respectively (EPA 2007). Solvent extraction technologies have been selected as the remedial action for PCB-contaminated soils or sediments for at least four Superfund sites, and technology vendors reported more than 90 to 98 percent contaminant removal (EPA 2013c).

Implementability – Multiple solvents might need to be used to extract both radionuclides and hazardous chemical from mixed waste. Performance may require a high number of extraction stages (6 to 8), especially at higher initial concentrations. Moisture content, the amount of clays, percentage of fines, and the amount of naturally occurring organic carbon may each affect the performance of a solvent extraction process of system design and operation, and many extraction processes can only handle a small particle size, usually less than ¼ inch. (EPA 2013c). The waste may need to be made pumpable by adding solvents or water while other systems may require reduction of the moisture content (<20 percent moisture) to effectively treat contaminated media (EPA 2013c). Additionally, the treatment equipment necessary for solvent extraction have a large footprint, which is not available in the area of the site.

Relative Cost – High capital/O&M costs (no O&M cost after the PRG is achieved).

Conclusion – Solvent and chemical extraction are eliminated from further consideration due to the complicated nature of the chemical process, the uncertainty in extraction efficiency, and the lack of space for the treatment equipment footprint.

2.6.7.5 Solidification/Stabilization

Solidification refers to techniques where additional materials are mixed into the contaminated materials to affect the physical condition of the contaminated materials. This is typically done to encapsulate the waste, forming a more solid material that is less permeable and has a higher strength. Solidification does not necessarily involve a chemical interaction between the contaminants and the solidifying additives. Typical solidification agents include Portland cement, silica grout, or chemical grout.

Stabilization refers to techniques where the additives are mixed into the contaminated materials or wastes affecting the chemical condition of the stabilized materials. The process chemically reduces the hazard potential of the contaminated material by chemically converting the contaminants into less leachable, soluble, mobile, or toxic forms.

The goal of solidification and stabilization is to treat the contaminated soil, resulting in a material that meets performance criteria associated with the following properties:

- Hydraulic Conductivity: To manage water exposure and isolate the solidified/stabilized contaminated soils from groundwater, surface water, or rain water infiltration
- Leachability: To retain contaminants in the solidified/stabilized materials, resulting in concentrations below regulatory criteria in any leachate generated from water contact
- Strength: To withstand overlying loads on the solidified/stabilized materials

Solidification/Stabilization (S/S) are fundamentally different from other treatment technologies in that they reduce the mobility of the contaminants but do not concentrate or destroy them. S/S can be implemented either as an in situ or ex situ process.

Effectiveness – The objective of treatment at the site is to reduce the gamma radiation emanating from the radionuclide contamination that causes risk to human health. S/S would be effective at reducing exposure to PCBs and BAP; however, S/S would not be effective at reducing gamma radiation emanating from the radionuclide contaminated soils. Radon/thoron release during mixing would also be a concern.

Implementability – S/S is implementable. Vendors and equipment are readily available.

Relative Cost – Moderate to high capital/moderate O&M costs.

Conclusion – S/S is not retained for further consideration due to lack of effectiveness.

2.6.7.6 Vitrification

This technology immobilizes radioactive contaminants by trapping them in an impervious matrix. Vitrification processes are solidification methods that use heat of up to 1205°C (2,200°F) to melt and convert waste material into chemically stable, leach-resistant, glasslike crystalline products (EPA 2013c). Radionuclides are retained within the vitrified product. The destruction mechanism is either pyrolysis (in an oxygen poor environment) or oxidation (in an oxygen rich environment). Vitrification can either be performed in situ or ex situ. In the in situ vitrification process, electricity is applied to electrodes placed in the ground over the waste mass. The ground and waste mass heat and melt, and the melting zone grows downward. The volume of the vitrified product is typically 20 to 45 percent less than the volume of the untreated soil or sediment. During vitrification, many substances volatilize; therefore, extra precautions are required. A hood to capture gases can be placed over the treatment zone.

Vitrified material near the surface would require removal for placement of common fill and top soil. The crystalline product in the subsurface would limit the future use of the site.

Effectiveness – Radon trapped in the material matrix could be released during the process, and radium may volatilize, requiring gas collection and treatment devices. This would require treatment of the off-gas waste stream. Additionally, the vitrified material would remain radioactive; therefore, shielding would be required for protection from gamma radiation.

Vitrification would be effective for PCBs and BAP across a wide range of soil characteristics, however, vitrification has been selected as the remedial action for PCB-contaminated soils or sediments at only two Superfund sites (EPA 2013c). Effectiveness is highly dependent on the nature of the subsurface; heterogeneity of the material and a variable depth to bedrock also would impact effectiveness.

Implementability – The technology requires a significant, reliable source of electrical power. The technology is mainly dependent on the electrical conductivity of the materials to be treated and produces other residuals that must be treated and/or disposed.

Relative Cost – High capital/O&M costs.

Conclusion – Based on the ineffectiveness to reduce gamma radiation and the production of residuals that will need to be treated or disposed, vitrification is eliminated from further consideration.

2.6.7.7 Phytoremediation

Phytoremediation is the use of plants for treatment of contaminant soils and sediments. Because radionuclides cannot be biodegraded, the only phytoremediation mechanisms applicable to radionuclides are phytoextraction and phytostabilization. In phytoextraction, high biomass radionuclide-accumulating plants and appropriate soil amendments are used to transport and concentrate radionuclides into the above-ground shoots, which are then harvested. The harvested biomass will contain residual waste and will need to be further treated and/or disposed of as radioactive waste. Phytostabilization involves using plants that produce chemical compounds which stabilize radionuclides in soils on the interface between roots and radioactive waste to render the radionuclides harmless (Hu et al. 2014).

Effectiveness – Based on testing and field trials, the most promising candidates for phytoextraction appear to be cesium-137 and strontium-90 while little research or field testing has been done on phytostabilization of radionuclides (EPA 2007). Therefore, there is no evidence presented that would support the effectiveness of this technology to remediate Th-232 and Ra-226. Additionally, roots can only penetrate shallow depths and therefore, cannot reach contamination at deep depths.

Implementability – Because of site setting, phytoremediation is not readily implementable across the site. The appropriate plants would need to be selected and planted. Maintenance of the plantings is necessary, including possible spraying for insect pests, trapping or fencing for animal pests, controls of weeds, irrigation, and fertilization. Several harvests will likely be necessary before reduction targets are achieved.

Relative Cost – Low capital/O&M costs.

Conclusion – Based on the lack of evidence to support effectiveness of this technology in remediation Th-232 and Ra-226, it is not retained for further consideration.

2.6.7.8 Electrokinetics

Electrokinetic remediation is an in situ extraction process that separates and extracts radionuclides from soils, sludges, and sediments. It is performed by applying a low voltage direct current across electrode pairs that have been implanted in the ground on each side of the contaminated soil mass (EPA 2007). Charged compounds in the subsurface move towards the electrodes. Electrokinetics is primarily used to remove metals and radionuclides in low permeability soils.

Effectiveness – This technology has not yet been proven to remove thorium and radium from soils. In fact, using this process, removal of radium and thorium were much less successful than removal of uranium because of formation of insoluble precipitates in the soil (EPA 2007). Additionally, effectiveness is decreased for wastes with a moisture contact of less than 10 percent.

Implementability – Vendors and equipment are available.

Relative Cost – High capital/O&M costs.

Conclusion – This technology is not retained due to lack of effectiveness for site contaminants and in site soils.

2.6.8 Emerging Technologies

2.6.8.1 Magnetic Separation

Magnetic separation is a physical separation process that segregates materials on the basis of magnetic susceptibility. Thorium is paramagnetic and radium is diamagnetic.

Effectiveness – This technology has not yet been proven to remove thorium and radium from contaminated soils in either a pilot-scale or full-scale demonstration.

Implementability – This is an emerging technology. Therefore, vendors and equipment are not readily available.

Relative Cost – High capital/O&M costs.

Conclusion – This technology is not retained due to lack of effectiveness for site contaminants and implementability issues.

2.6.8.2 Bacterial Reduction

Bioremediation uses bacteria to degrade organic compounds by using organics as food and oxidizing them. In bacterial reduction, bacteria use an electron donor in respiration and transfer electrons to an acceptor, such as a radionuclide. For some radionuclides, this causes them to precipitate out of solution. This technology has only been tested on uranium.

Effectiveness – Bioremediation has shown some degree of success in laboratory and pilot-scale applications for PCB contamination; however, comprehensive field scale research is needed to advance bioremediation technology for PCB-contaminated soils. Additionally, this technology has not yet been proven to remove thorium and radium from solution; however, thorium and radium cannot typically change oxidation state. Finally, since the contamination exists in the vadose zone, this technology could not be applied to contaminated soils without first saturating the soils.

Implementability – This is an emerging technology. Therefore, vendors and equipment are not readily available.

Relative Cost – High capital/O&M costs.

Conclusion – This technology is not retained due to lack of effectiveness for site contaminants and implementability issues.

2.6.9 Additional Remedial Technologies for Indoor Air

In addition to the ICs/ECs and inspection, maintenance, and monitoring technologies described above, radon and thoron in indoor air could be addressed with the use of a radon mitigation system.

Air pressure fluctuations within a structure pull soil gas (containing radon and thoron) from below the foundation into living spaces. Radon mitigation is any process used to reduce the radon and thoron gas concentrations in the breathing zones of occupied buildings. Active subslab suction, also called subslab depressurization, is the most common radon mitigation system and usually the most reliable radon reduction method. One or more suction pipes are inserted through the floor slab into the crushed rock or soil underneath. They also may be inserted below the concrete slab from outside the building. The number and location of suction pipes that are needed depends on how easily air can move in the crushed rock or soil under the slab and on the strength of the radon source. Mitigation systems extend a slight vacuum under the structure to pull impacted air away from living spaces and direct it towards the outside. It may be possible to create a passive radon system by creating a vacuum through natural stack effect in the suction pipes. A passive system can be converted to active radon systems by installing a radon vent fan.

For new buildings that may be installed on the WACC lots in the future, radon resistant new construction techniques can be used to prevent radon gas entry in the newly constructed building. Most radon resistant designs consist of a gas permeable layer of gravel under a concrete slab, a soil gas collection pipe buried within the gravel layer, a suction pipe that extends through an interior wall, the exhaust point above the roof of the structure, and the soil vapor retarder layer constructed below the foundation of the building.

<u>Effectiveness</u> – Active radon mitigation systems can achieve 50-99% reduction in radon air concentrations. Radon monitoring and system maintenance would be required indefinitely to ensure the system is working effectively.

<u>Implementability</u> – Different radon mitigation approaches are available depending on the building foundation type. Contractors, vendors and equipment are readily available. Standards addressing radon resistant new construction for buildings larger than a one- and two-family dwelling are detailed in ANSI/AARST Standard CC-1000-2017, Soil Gas Control Systems in New Construction of Buildings.

<u>Relative Cost</u> – Low capital/low to moderate O&M costs.

<u>Conclusion</u> – Retained for further consideration.

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Section 3

Development of Remedial Action Alternatives

In Section 2, screening of available remedial action technologies and process options was performed. In this section, remedial action alternatives (herein referred to as remedial alternatives) are assembled by combining the retained remedial technologies and process options presented in Section 2. Remedial alternatives are developed from either stand-alone process options or combinations of the retained process options to address the site-specific RAOs.

3.1 Development of Remedial Action Alternatives

Several technologies and process options were retained for contaminated materials based on the screening in Section 2. The retained technologies and process options are summarized below.

- No action
- Institutional and engineering controls
- Inspection, maintenance, and monitoring
- Capping
- Excavation
- Landfill disposal

The retained technologies were combined to develop remedial action alternatives. To develop remedial alternatives for the site, representative process options were selected from the same groups of remedial technologies, as appropriate. However, other technologies and process options may still be applicable and should be considered during the remedial design stage of the project. The retained technologies and process options were combined into four alternatives.

The four alternatives developed for the site are listed below.

- Alternative 1 – No Further Action
- Alternative 2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs
- Alternative 3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs
- Alternative 4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal

3.2 Description of Remedial Action Alternatives

This section details the remedial alternatives. Note that this FS describes a conceptual approach for the remedial action. Where appropriate, assumptions are made for cost estimating purposes. For example, it is assumed that in addition to the WACC property, Lot 31 and Lot 30 (former rail spur area) would be used for consolidation and/or staging purposes. The final approach for remedial action would be determined during the remedial design.

3.2.1 Common Elements

Certain components and sub-components of the remedial alternatives, such as sewer line excavation and other property excavation, are common to Alternatives 2 through 4 developed in this FS (except the No Further Action alternative). The common elements included as part of Alternatives 2 through 4 are described here.

3.2.1.1 Sewer Line Excavation/Sewer Jet Cleaning

Sewer line excavation/sewer jet cleaning would be applied as a common element across all alternatives, with the exception of the No Further Action alternative. A criterion of 10,000 cpm and/or soil concentrations above PRGs were used to delineate the sewer pipe requiring removal or jet cleaning as discussed in Section 2.4. **Figure 3-1** presents the sewer line excavation/jet cleaning plan.

For the FS, it is assumed that the clay pipe sewer line beginning at Manhole I-1 on Irving Avenue southwest of the WACC property and extending northwest to Manhole I-4 would require removal along with soil contaminated by leaks in the sewer line based on sample data collected from the sewer construction material, The sewer construction material sample results from this portion of the sewer showed Ra-226 concentrations ranging from 76 pCi/g to 163 pCi/g, and Th-232 concentration ranging from 2,206 pCi/g to 2,536 pCi/g.

The remaining portion of the sewer line from Manhole I-4 to the Irving Avenue and Halsey Street intersection, and ending at the Halsey Street and Wyckoff Avenue intersection would undergo jet cleaning using high-pressure water nozzles to flush out dirt, sediments/sludge, and any other matter from the sewer pipeline. Additionally, based on elevated gamma counts, the portion of clay sewer pipe from Manhole C-1 (northwest of Lot 48 on Cooper Avenue) to Manhole I-3 at the Irving Avenue/Cooper Avenue intersection also would undergo jet-cleaning. A vacuum truck would be employed downgradient from the section of the sewer being flushed to capture all flushed materials for offsite disposal.

Following completion of sewer jet cleaning, a gamma survey would be performed within the flushed sewer to determine if high gamma counts (i.e., above 10,000 cpm) are still present. Any portions of the sewer line where gamma counts are still greater than 10,000 cpm would undergo further investigation including bedding and sewer material sampling to determine the level and extent of contamination. Those portions of the sewer line, along with contaminated bedding material that exceed PRGs would be removed and replaced. For FS cost estimating purposes only, it is assumed based on consistently elevated gamma counts, that the portion of the sewer lines from Manhole I-4 (50 feet from Irving Avenue/Cooper Avenue intersection) through Manhole I-11 (approximately 120 feet northwest of the Irving Avenue/Covert Street intersection) on Irving Avenue, and from Manhole C-1 (northwest of Lot 48 on Cooper Avenue) to Manhole I-3 at the

Irving Avenue/Cooper Avenue intersection would require removal and replacement following additional investigation after jet cleaning; however, the actual extent of additional sewer line requiring removal and replacement would be based on the outcome of the additional investigation.

Excavation to the target depths could be achieved using a piling system of steel I-beams and hard wood sheeting with walers, spacers, and braces. Excavation activities would be coordinated with local municipalities including the police and fire department.

For cost estimating purposes, it is assumed that soils above the sewer line are clean (except for those soils from 0-2 feet bgs at the soil boring location SWSB-03 and those from above the pipeline from Manhole I-1 to Manhole I-2 [at the intersection of Irving Avenue and Cooper Avenue] that would be excavated as part of the contaminated soils excavation) and would be used for backfill following sewer line replacement. It is also assumed, for cost estimating purposes, that soils on either side of the pipe below the top of the sewer pipe and 6 inches under the sewer pipe are contaminated and would require excavation. Contaminated soils and removed sewer construction debris would be disposed of in an approved radioactive waste landfill. Prior to disposal, waste characterization samples would be collected from all materials.

The volume of sewer line construction debris and contamination soils is presented in **Appendix D-1**. The volume of sewer line construction debris is estimated to be 80 tons and the volume of contaminated soils associated with the sewer removal is estimated to be 800 cy.

Final Status Survey (FSS) including gamma scan and confirmation samples would be collected to confirm that all contaminated material exceeding PRGs have been removed. Gross gamma count rate survey of remediated areas will be performed to identify any potential areas of elevated activity are present. Upon completion of the gross gamma count rate survey, confirmation samples would be collected in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG 2000, 2001). The number of survey units and samples within each survey unit would be calculated using MARSSIM guidance.

Following sewer removal and excavation, new sewer pipe would be installed and excavated fill that is clean and additional clean fill would be used to backfill the excavated pit. The roadway would be replaced.

To maintain uninterrupted sewer service during sewer placement, sewage flow from upgradient would need to temporarily bypass the portion of sewer line under construction to the downgradient sewer line. To do this, a sewage bypass system capable of the design flow capacity of the upgradient sewer line would be utilized. A temporary bypass system would be installed in the upgradient manhole to the downgradient manhole. Temporary plugs would be set in place between these points to allow the sewer pipe to be removed.

To select the proper pump and equipment, bypass contractors would need to determine peak flow, sewer line pipe size and depths; duration of the work; access issues; and other issues such as contingency planning for sewage spills. In addition, the potential public and environmental impact of the bypass operation would require monitoring throughout the course of the project. For cost estimating purposes, the cost of a temporary sewage bypass system and piping equipment was estimated using an estimated flow based on pipe dimensions and other assumptions. Detailed cost estimates are presented in **Appendix F**. The calculations completed to estimate the flow are presented in **Appendix G**.

3.2.1.2 Pre-Design Investigation

Additional Delineation and investigation

A utility investigation is required to identify and locate underground utilities, specifically those within the sewer line excavation area such as the water main.

Additional vertical and horizontal delineation is required to fully delineate the horizontal and vertical extent of soil contamination above PRGs. Specifically, delineation activities on Irving Avenue south of the WACC property to determine the depth of excavation and the horizontal extent of the excavation, including underneath buildings, would need to be performed. Investigation also would need to be conducted in this area to find the exact location of manhole I-1 which is the beginning of the Irving Avenue sewer line.

Other Potentially Impacted Properties

A review of nearby properties (**Figure 3-2**) was completed to evaluate whether they could have been impacted by WACC processes. The age of the nearby buildings was compared to the timeframe during which WACC conducted rare earth metals extraction at the WACC property (1920s to 1954). If a building structure was present on the property prior to 1924 and remained on the property until at least 1954, the property was unlikely to have been impacted. However, if a building was constructed after WACC began processes, the property could have been impacted.

The review of the nearby properties indicated six properties may have been impacted by WACC operations. However, no data were collected at three properties, including the parking lot for 335 Moffat Street, 323 Moffat Street, and 282 Moffat Street. In addition, only minimal data were collected at some properties including 335 Moffat Street and 338-350 Moffat Street. For example, radon concentrations in samples collected in a pottery shed located behind 338-348 Moffat Street were elevated; however, soil sample collection below the shed was not possible without damaging the shed flooring. Therefore, the presence of soil contaminated under the shed has not yet been established.

As part of Alternatives 2 through 4, an investigation would be conducted to fill these data gaps during the design phase. For the purposes of this FS and cost estimates, it is assumed that 100 cy of soil would require remediation. It is also assumed that these 100 cy of soil would be below a building slab and would require demolition of a concrete slab prior to excavation. Excavated and removed soil and debris would be disposed of in an offsite landfill approved to receive radioactive soil and debris. Following excavation and FSS, clean fill would be used to backfill the excavation pit and compacted. A new concrete floor would be installed in place of the floor that was removed.

3.2.1.3 Phased Approach to Remedial Activities

It is anticipated that a phased approach would be employed for all the alternatives to minimize disruptions and short-term risk to the community.

3.2.2 Detailed Description of Alternatives

Remedial alternatives developed for contamination at the site are described in this section. Detailed cost estimates for each alternative are presented in **Appendix F**.

3.2.2.1 Alternative 1 – No Further Action

In 2013, EPA conducted radiation mitigation activities by installing fencing at the site and shielding portions of the radioactive soil with rock and clean fill to reduce accessibility to the waste material. Additional shielding consisting of lead, steel, and concrete was installed within several structures at the WACC property and along a portion of the Irving Avenue sidewalk. A radon mitigation system was also installed within one building.

A "no action" alternative is required by the NCP to provide an environmental baseline against which impacts of the various remedial alternatives can be compared. Since action has already been taken at this site, under this alternative, no further action would be taken to remediate or monitor contamination at the site to address the associated risks to human health. This also includes no maintenance of the radon mitigation system currently in place. The No Further Action alternative was retained in accordance with the NCP to serve as a baseline for comparison with the other alternatives.

3.2.2.2 Alternative 2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

This alternative consists of the following major components:

- Temporary relocation of tenants in Lots 42, 44, and 46
- Demolition of the warehouse building on Lot 33
- Excavation of shallow contaminated soils exceeding the PRGs to a maximum depth of 4 feet
- Excavation of contaminated sewer pipe from Manhole I-4 to the Irving Avenue and Halsey Street intersection, and ending at the Halsey Street and Wyckoff Avenue intersection and sewer line jet cleaning of the remaining portion of sewer pipe from Manhole I-4 to the Irving Avenue and Halsey Street intersection, and ending at the Halsey Street and Wyckoff Avenue intersection; and, the portion of sewer pipe from Manhole C-1 to Manhole C-3 as described in Section 3.2.1.1
- Final status survey (gamma scan and confirmation samples)
- Disposal of building debris, excavated soils, sewer pipe and sediment in a permitted landfill for radioactive waste
- Site restoration
- Installation of shielding (within buildings on Lots 42,44 and 46)

- Maintenance of the radon mitigation system in building in Lot 42 and conduct radon monitoring in all buildings after excavation and backfill
- Institutional controls (e.g., environmental easement)
- Long-term monitoring
- Conduct five-year reviews

Temporary relocation of tenants in Lots 42, 44, and 46 – During the construction period, the tenants occupying buildings at this lots would be temporarily relocated.

Demolition – Because of the widespread nature of surficial soil contamination under the warehouse, demolition of the warehouse on Lot 33 would eliminate an impedance and give the best and most economical approach for addressing the risk associated with contamination in the underlying soils. The building located on Lot 33, including the building slab and foundation, would be demolished. Prior to physical demolition of the building, the following activities would be conducted:

- Segregation of asbestos containing material and lead-based paint for separate disposal at a construction and debris landfill
- Additional delineation of contamination, as required
- Nonstructural component removal
- Demarcation of radionuclide-contaminated construction materials for demolition
- Utility abandonment
- Establishment of dust control measures
- Establishment of water management measures (for dust suppression and surface runoff)
- Establishment of stockpile locations

Stockpiles of debris would be tarped, and dust suppression techniques would be employed. Demolition debris would be segregated based on the level of radioactivity of the materials measured using gamma radiation meters. Materials with radioactivity within the range of background would be disposed of in a non-hazardous waste landfill located in Pennsylvania (e.g., IESI/Progressive Waste Solutions) while materials with radioactivity counts would be disposed of in a landfill permitted to accept radioactive waste located in Idaho (e.g., U.S. Ecology). For this FS, the determination of radiological waste for the walls, ceilings, and roofs were based on chip samples and gamma readings collected during the RI while the floors are assumed to be radiological waste. It is also assumed that asbestos-containing waste and lead paint do not contain radiological contamination. The total volume of demolition debris is presented in **Appendix D-2**. The total volume of radiologically contaminated demolition debris is estimated to be 440 tons and the total volume of uncontaminated demolition debris is estimated to be 620 tons. The volume of asbestos waste is assumed to be nominal.

Soil Excavation – After building demolition at Lot 33 has been completed, contaminated soils at the site exceeding the PRGs would be excavated to a depth of 4 feet bgs except in areas where contamination is shallower than 4 feet. The majority of radionuclide contamination in soils on Lot 33, the former rail spur area, Cooper Avenue, and the 308 Cooper Avenue property extends to 2 feet bgs, with an area extending down to 3 feet bgs in Lot 33, and to 4 feet bgs near the southeastern corner of Lot 33. These areas would be excavated to 2, 3, and 4 feet, respectively. Sloping and benching would be utilized for these excavations.

As part of this alternative, areas of deeper contamination on Irving Avenue, Moffat Street, and the 350 Moffat Street property would only be excavated to 4 feet bgs. Contamination on Irving Avenue and Moffat Street would require demolition of the roadway and sidewalks prior to excavation. Soil contamination below 4 feet extending down to 6, 8, and 20 feet bgs would remain in place. To determine a target shallow excavation depth that would be protective of future-use scenarios including industrial, recreational, and residential, a RESRAD model was used to calculate risk based on three different depths of cover and leaving contamination below that depth in place. Model results are shown in **Appendix H**. The 4-foot cover results in less risk for all three scenarios but risk levels are still above EPA's acceptable range of risk. However, most of the risk is attributable to radon and would only be a risk to the human receptors in a building, as radon emanating from outdoor areas would be diluted with the atmosphere. Additionally, the 4-foot of excavation would allow utility work to be completed below the frost line with minimal chance of exposure.

The excavation plan for this alternative is presented on **Figure 3-3**. The total volume that would be excavated under this alternative is 13,700 bank cubic yards (bcy) of soil (22,000 tons of soil). The calculations are presented in **Appendix D-3**.

Fencing would also be installed to secure the excavation area from trespassers. Excavation activities would be coordinated with local municipalities including the police and fire department.

Excavation activities would be conducted in a manner that minimizes worker exposure and protects the environment from site contaminants (i.e., a designated work area boundary would be established and appropriate PPE would be utilized). Soil stockpiles would be placed in designated areas and if placed in an area of uncontaminated soils, a layer of heavy-duty plastic sheeting would be installed prior to soil stockpiling. Where possible, excavated soils would be stockpiled on areas with improved asphalt or concrete surface also lined with heavy-duty plastic. Unauthorized access to such areas would be prevented by fencing. Soil stockpiles would be covered with material adequate to prevent soil transport by wind or rainwater runoff. Covers would be required to be maintained in good condition. When not covered, soil stockpile surfaces would be kept visibly moist by water spray to prevent dust migration, as necessary.

Due to the limited space at the site, demolition, excavation, and segregation of the soils for offsite disposal, and backfill and restoration, would need to be sequenced in several phases to achieve the goals of the remedy.

Sewer Line Excavation/Replacement and Jet Cleaning – Contaminated portions of the sewer line would be removed and replaced or flushed via jet cleaning as discussed in Section 3.2.1.1.

Final status survey – Upon completion of all remediation activities, gamma scan surveys, confirmation sampling of remediated areas, and exposure rate measurements would be conducted in accordance with MARSSIM to confirm that all contaminated material exceeding PRGs has been removed. The number of survey units and samples within each survey unit would be calculated using MARSSIM guidance.

Secondary excavation would be performed based on the gamma scan surveys and post-excavation sample results exceeding the PRGs in 1-foot increment for sidewall exceedances and in 6-inch increment for bottom exceedances. However, the depth of excavation will be to maximum of 4 feet bgs, and the sidewalls along the buildings will be limited to foundation wall. Benching would be utilized to prevent destabilizing the building foundation. For cost-estimating purposes, a secondary excavation volume of 10% (870 cy) is assumed.

Excavated materials segregation and disposal – The excavated soils and sewer materials would be separated into two categories:

- Radiologically-contaminated soils with PCBs exceeding 50 mg/kg, and
- Radiologically -contaminated soils with PCB concentrations below 50 mg/kg.

Each category of soils is assumed to contain radionuclide contamination at varying activity levels. For cost estimating purposes, it is assumed that all soils and demolished roadway and sidewalks would be disposed of at a radioactive waste landfill located in Idaho (e.g., U.S. Ecology). It is assumed that 80 tons of excavated soils would contain PCBs at concentrations greater than 50 ppm and would be disposed of in a landfill permitted for waste with PCBs and radionuclides located in Texas (e.g., Waste Control Specialist). In total, Alternative 2 assumes a disposal of 27,400 tons of materials from the site with each truck carrying 20 tons. Based on total estimated volume of materials to be disposed offsite, approximately 1,400 truckloads of waste would be transported off-site under Alternative 2.

Site restoration – At the completion of excavation, restoration of the site would be conducted. Imported clean fill would be used for backfill of the excavated areas in accordance with a site restoration plan. A layer of geofabric would be placed between the contaminated soil on both the excavation bottom and excavation sidewalls and the clean backfill to demarcate the limit of clean fill. Roadway and sidewalk would be constructed to replace any roadway and sidewalk removed as part of the excavation on Moffat Street and Irving Avenue. Restoration of roadways and sidewalks would be conducted pursuant to NYC Infrastructure Design Standards that are current at the time of construction. Standards include NYC Department of Transportation (DOT) Standard Highway Specifications and NYC DOT Standard Details of Construction. For cost estimation purposes, it is assumed that gravel would be placed on Lot 33 after backfill is brought to grade. A fence would be constructed around the Lot 33 property.

Placement of lead shielding – A 1-inch layer of lead shielding and a 1-inch steel plate would be installed on top of the existing floors of the buildings on Lots 42 and 44 and on the sidewalk. A 1-inch layer of lead shielding and a 1-inch steel plate would also be installed on the basement side wall of the deli on Lot 46 along the property boundary with Lot 44. It is likely that the gamma scan results on this wall are elevated due to high levels of contamination in soils on the other side.

Long-term monitoring and maintenance – A long-term monitoring plan would be put in place to monitor radon and thoron levels in the site buildings remaining at the WACC property. Maintenance of the existing radon system would continue. For cost estimating purposes, it is assumed that groundwater samples would be collected from monitoring wells periodically to monitor if contaminants would leach over time and that radon monitoring and groundwater monitoring would be conducted once per year. However, the specific monitoring program components would be identified in the remedial design. For FS costing comparison purposes, a 30-year period of performance is assumed, however, the actual period of performance required for these tasks would be indefinite.

Institutional controls (environmental easement) – An environmental easement would be recorded for Lots 42, 44, and 46; Irving Avenue and Moffat Street; and the 350 Moffat Avenue property, which would limit intrusive activity (including future construction of a basement), provide a description of contamination remaining in these areas, require access for monitoring, the use restrictions, and a map to show the area for restricted use. Since all contamination would be removed in Lot 33, an environmental easement would not be required.

Alternative 2 would have an estimated construction duration of 1 year and 3 months and incur high costs. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

3.2.2.3 Alternative 3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

This alternative consists of the following components:

- Permanent relocation of tenants in WACC buildings
- Demolition of buildings on Lots 33, 42, 44, 46, and 48
- Excavation of shallow contaminated soils exceeding the PRGs to a maximum depth of 4 feet
- Excavation of contaminated sewer pipe and sewer line jet cleaning as described for Alternative 2
- Final status survey (gamma scan and confirmation samples)
- Disposal of building debris, excavated soil, sewer pipe, and sediment in a permitted landfill for radioactive waste
- Site restoration
- Institutional controls (e.g., environmental easement)
- Long-term monitoring

Permanent relocation of tenants in Lots 42, 44, 46, and 48 – Due to the demolition of the buildings on these lots, the tenants would be permanently relocated.

Demolition – All buildings on the former Wolff-Alport property would be demolished. Demolition and materials segregation would be completed as discussed under Alternative 2. The total volume of demolition debris is presented in **Appendix D-2**. The total volume of radiologically-contaminated demolition debris is estimated to be 2,600 tons and the total volume of uncontaminated demolition debris is estimated to be 2,200 tons. The volume of asbestos waste is assumed to be nominal.

Soil Excavation – After building demolition, contaminated soils at the site exceeding the PRGs would be excavated to a depth of 4 feet bgs. The majority of radionuclide contamination in soils on Lot 33, the former rail spur area, Cooper Avenue, and the 308 Cooper Avenue property extends to 2 feet bgs, with an area extending down to 3 feet bgs in Lot 33, and to 4 feet bgs near the southeastern corner of Lot 33. These areas would be excavated to 2, 3, and 4 feet, respectively. Sloping and benching would be utilized for these excavations.

As part of this alternative, areas of deeper contamination on Irving Avenue, Moffat Street, and the 350 Moffat Street property would only be excavated to 4 feet bgs. The highly contaminated soils at Lots 42 and 44 below the 4-foot excavation depth to approximately 28 feet bgs would also remain in place. However, risk calculations discussed in Section 3.2.2.1 and presented in **Appendix H** show that, if a building is constructed at the property in the future, the 4-foot soil cover and a radon mitigation system would reduce risk to within EPA's acceptable risk range. Other areas of soil contamination would be excavated as discussed under Alternative 2. The excavation plan for this alternative is presented on **Figure 3-4**. The total volume that would be excavated under this alternative is 14,200 bcy of soil (22,800 tons of soil). The calculations are presented in **Appendix D-3**.

The difference in volumes between Alternative 2 and Alternative 3 is minimal since the volume added as part of Alternative 3 would only include 4 feet of soils from the contaminated areas at Lots 42, 44, 46, and 48. However, this alternative would allow more soils in hotspot areas to be removed from the site.

Sewer Line Excavation/Replacement and Jet Cleaning – Contaminated portions of the sewer line and associated contaminated soils would be removed and replaced or flushed via jet cleaning as described in Section 3.2.1.1.

Final status survey – Upon completion of all remediation activities, gamma scan surveys, confirmation sampling of remediated areas, and exposure rate measurements would be conducted as described for Alternative 2. For cost-estimating purposes, a secondary excavation volume of 10% (900 cy) is assumed.

Excavation materials segregation and disposal – Excavated materials would be segregated and disposed of as discussed under Alternative 2. Alternative 3 assumes a disposal of 32,000 tons of materials from the site with each truck carrying 20 tons. Based on total estimated volume of materials to be disposed offsite, approximately 1,600 truckloads of waste would be transported off-site under Alternative 3.

Site restoration – Clean backfill would be placed over the contaminated soils left in place following excavation. A layer of geofabric would be placed between the contaminated soil on both the excavation bottom and excavation sidewalls and the clean backfill to demarcate the limit of clean fill. The backfill for the soil cover on the WACC property would be graded for positive drainage to avoid standing water and minimize infiltration over the remaining contamination on the site to generally follow and maintain existing drainage patterns. For areas not included as part of roadway and sidewalk restoration as described under Alternative 2, top soil would be used for the top 6 inches of backfill, and the area would be seeded and fertilized. A fence would be constructed around the WACC property.

Long-term monitoring – Annual inspection of the soil cover would be performed to monitor soil erosion and ensure continued protection of human health. The soil cover would be maintained as necessary. For cost estimating purposes, it is assumed that groundwater samples would be collected from monitoring wells periodically to monitor if contaminants would leach over time, and that groundwater monitoring would be conducted once per year. However, the specific monitoring program components would be identified in the remedial design. For FS costing purposes, a 30-year period of performance is assumed, however the actual period of performance required for these tasks would be indefinite.

Institutional controls (environmental easement) – An environmental easement would be recorded for Lots 42, 44, and 46; Irving Avenue and Moffat Street; and the 350 Moffat Avenue Property, which would limit intrusive activity (including future construction of a basement), provide a description of contamination remaining in these areas, the use restrictions, and a map to show the area for restricted use. The environmental easement would also set the procedures for intrusive work if it is needed in contaminated soils (e.g. for maintenance, repair or replacement of underground utilities). Since all contamination would be removed in Lot 33, an environmental easement would not be required. the environmental easement would include the stipulation that if a new building were erected on the property, a radon mitigation system for that building would be required.

Alternative 3 would have an estimated construction duration of 1 year and 4 months and incur high costs. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

3.2.2.4 Alternative 4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal

This alternative consists of the following components:

- Permanent relocation of tenants in WACC buildings
- Demolition of all WACC property buildings
- Excavation of all soils exceeding PRGs

- Excavation of contaminated sewer pipe and sewer line jet cleaning as described for Alternative 2
- Final status survey (gamma scan and confirmation samples)
- Disposal of building debris, excavated soil, sewer pipe, and sediment in a permitted landfill for radioactive wastes
- Site restoration

Permanent relocation of tenants in Lots 42, 44, 46, and 48 – Due to the demolition of the buildings on these lots, the tenants would be permanently relocated.

Demolition – Demolition of all buildings would be completed as described under Alternative 3. The total volume of demolition debris is presented in **Appendix D-2**. The total volume of radiologically contaminated demolition debris is estimated to be 2,600 tons and the total volume of uncontaminated demolition debris is estimated to be 2,200 tons. The volume of asbestos waste is assumed to be nominal.

Soil Excavation – Following building demolition, all soils at the site exceeding the PRGs would be excavated, including those highly contaminated soils that extend to 28 feet bgs in Lots 42 and 44. The excavation plan for this alternative is presented on **Figure 3-5**. The total volume that would be excavated under this alternative is 18,000 bcy of soil (28,800 tons of soil) and would include removal of all hotspots. The calculations are presented in **Appendix D-3**.

Sewer Line Excavation/Replacement and Jet Cleaning – Contaminated portions of the sewer line and associated soils contaminated soils would be removed and replaced or flushed via jet cleaning as described in Section 3.2.1.1.

Final status survey – Upon completion of all remediation activities, gamma scan surveys, confirmation sampling of remediated areas, and exposure rate measurements would be conducted in accordance with MARSSIM to confirm that all contaminated material exceeding PRGs has been removed. The number of survey units and samples within each survey unit would be calculated using MARSSIM guidance.

Secondary excavation would be performed based on the gamma scan surveys and confirmation sample results. For cost-estimating purposes, a secondary excavation volume of 10% (2,000 cy) is assumed.

Excavation materials segregation and disposal – Excavated materials would be segregated and disposed of as described under Alternative 2. Alternative 4 assumes a disposal of 38,300 tons of materials from the site with each truck carrying 20 tons. Based on total estimated volume of materials to be disposed offsite, approximately 1,900 truckloads of waste would be transported off-site under Alternative 4.

Site restoration – At the completion of excavation, the site would be restored as described under Alternative 3. However, geotextile would not be required for this alternative as all contamination would be removed.

Alternative 4 would have an estimated construction duration of 1 year and 6 months and incur high costs. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

3.3 Alternative Screening

Since only a limited number of remedial alternatives were developed, screening of remedial action alternatives is not performed. All the alternatives are carried forward through the detailed description and evaluation.

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Section 4

Detailed Analysis of Remedial Action Alternatives

The remedial alternatives described in Section 3 are evaluated in this section against the criteria described below.

4.1 Evaluation Criteria

EPA's nine evaluation criteria address statutory requirements and considerations for remedial actions in accordance with the NCP and additional technical and policy considerations proven to be important for selecting among remedial alternatives (EPA 1988). The following subsections describe the nine evaluation criteria used in the detailed analysis of remedial alternatives.

4.1.1 Overall Protection of Human Health and the Environment

Each alternative is assessed to determine whether it can provide adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site. Evaluation of this criterion focuses on how site risks are eliminated, reduced, or controlled through treatment, engineered controls, or institutional controls and whether an alternative poses any unacceptable cross-media impacts.

4.1.2 Compliance with ARARs

Section 121(d) of CERCLA, 42 United States Code (USC) § 9621(d), the NCP, 40 CFR Part 300 (1990), and guidance and policy issued by EPA require that remedial actions under CERCLA comply with substantive provisions of ARARs from the state and federal environmental laws and commonwealth facility siting laws during and at the completion of the remedial action.

4.1.2.1 Identification of ARARs

The definition and identification of ARARs have been described and discussed in detail in Section 2.2. Three classifications of requirements are defined by EPA in the ARAR determination process. ARARs are defined as chemical-, location-, or action-specific. An ARAR can be one or a combination of all three types of ARARs. The federal and New York ARARs for the site are listed in **Tables 2-1 and 2-2**. Each alternative is evaluated to determine how chemical- and action-specific ARARs would be met.

4.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness evaluates the likelihood that the remedy would be successful and the permanence it affords. Factors to be considered, as appropriate, are discussed below.

- <u>Magnitude of residual risk</u> remaining from untreated waste or treatment residuals remaining after the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, considering their T/M/V and propensity to bioaccumulate.

- Adequacy and reliability of controls used to manage treatment residuals and untreated waste remaining at the site. This factor includes an assessment of containment systems and institutional controls to determine if they are sufficient to ensure any exposure to human and ecological receptors is within protective levels. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the remedial action need replacement.

4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Each alternative is assessed for the degree to which it employs a technology to permanently and significantly reduce T/M/V, including how treatment is used to address the principal threats posed by the site. Factors to be considered, as appropriate, include the items below.

- The treatment processes the alternatives employ and materials they would treat
- The amount of hazardous substances, pollutants, or contaminants that would be destroyed or treated, including how the principal threat(s) would be addressed
- The degree of expected reduction in T/M/V of the waste due to treatment
- The degree to which the treatment is irreversible
- The type and quantity of residuals that would remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents
- Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedial action

4.1.5 Short-Term Effectiveness

This criterion reviews the effects of each alternative during the construction and implementation phase of the remedial action until remedial response objectives are met. The short-term impacts of each alternative are assessed, considering the following factors, as appropriate.

- Short-term risks that might be posed to the community during implementation of an alternative
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures
- Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts
- Time until protection is achieved for either the entire site or individual elements associated with specific site areas or threats

4.1.6 Implementability

The technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation is evaluated under this criterion. The ease or difficulty of implementing each alternative is assessed by considering the following factors:

Technical Feasibility

- Technical difficulties and unknowns associated with the construction and operation of a technology
- Reliability of the technology, focusing on technical problems that will lead to schedule delays
- Ease of undertaking additional remedial actions, including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions

Administrative Feasibility

- Activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)

Availability of Services and Materials

- Availability of adequate offsite treatment, storage capacity, and disposal capacity and services
- Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources

4.1.7 Cost

Detailed cost estimates for each alternative were developed for the FS according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000). Detailed cost estimates for the alternatives are included in **Appendix F** and include the following:

- Capital costs
- Annual O&M costs
- Periodic costs
- Present value of capital and annual O&M costs

4.1.8 State (Support Agency) Acceptance

State (support agency) acceptance is a modifying criterion under the NCP. This criterion evaluates the technical and administrative issues and concerns the State may have regarding each of the alternatives and whether the State concurs with the preferred remedy. Assessment of State concerns will be completed after comments on the FS and proposed plan have been received by

EPA and are addressed in the ROD. Thus, state acceptance is not considered in the detailed evaluation of alternatives presented in this stage of the FS process.

4.1.9 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Community acceptance refers to the public's general response to the alternatives described in the FS report and Proposed Plan. EPA's assessment of concerns from the public will be completed after public comments on the FS and proposed plan have been received by EPA and are addressed in the ROD. Thus, community acceptance is not considered in the detailed evaluation of alternatives presented in this stage of the FS process.

4.2 Detailed Analysis of Remedial Alternatives

This section provides detailed analysis of the remedial alternatives developed in Section 3 for the site. **Table 4-1** presents a side-by-side view of the criteria analysis for all the alternatives. The remedial alternatives retained for detailed analysis are provided below.

4.2.1 Alternative 1 – No Further Action

Remedial Alternative Component Descriptions

The No Further Action alternative is required by the NCP to provide an environmental baseline against which impacts of the various remedial alternatives can be compared. As indicated in Section 3.2.2.1, no further action would be taken under Alternative 1.

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Contaminated soil, contamination in the building, and the CSS would be left unaddressed and would remain on the site. Alternative 1 would not include the implementation of any ICs, such as proprietary controls or future monitoring, and therefore, would not address RAOs.

The No Further Action alternative fails to meet the threshold criterion of protectiveness.

Compliance with ARARs

ARARs for the site are included in **Tables 2-1 through 2-3**. Because no action would be taken, the presence of unaddressed contaminated soil and CSS would not meet chemical-specific ARARs,

The No Further Action alternative fails to meet the threshold criterion of compliance with ARARs. Action and location-specific ARARs are not applicable since no action would be taken.

Long-Term Effectiveness and Permanence

Because the No Further Action alternative would not remove, treat, or contain the contaminated soils or CSS, the contamination left in place would continue to pose unacceptable risks to human health through direct exposure radium and thorium and through inhalation of radon and thoron. Additionally, the contamination would continue to migrate. The magnitude of risk from untreated waste would not change.

Additionally, no controls would be implemented at the site to prevent future exposure; thus, this alternative would have no long-term effectiveness and permanence.

Reduction of T/M/V through Treatment
No remedial action would be taken under Alternative 1; thus, there would be no reduction in toxicity, mobility, or volume of contaminated soil or contamination in the CSS. The statutory preference for treatment as a principal element of the remedial action would not be met.

Short-Term Effectiveness
Since no remedial action would be implemented at the site, this alternative would not pose short-term impact to onsite workers, the local community, and the ecological receptors. Similarly, this alternative would neither minimize nor increase greenhouse gas emissions, air pollutants, energy consumption, or water use because no action would be taken. Protection would not be achieved for the site under this alternative.

Implementability
Alternative 1 would not involve any administrative or technical implementation issues because no remedial action or ICs would be implemented. This alternative could be implemented immediately since no services or actions would be required.

Cost
There are no capital or O&M costs associated with this alternative.

4.2.2 Alternative 2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

Remedial Alternative Component Descriptions
The major components of Alternative 2 are described in Section 3.2.2.2. The components include demolition of the warehouse building located on Lot 33, excavation of soils as indicated in **Figure 3-3**, placement of lead shielding within buildings on Lots 42, 44, and 46, sewer line excavation and replacement and flushing via jet cleaning as described in Section 3.2.1.1, long-term monitoring and maintenance, and establishment of an environmental easement.

Overall Protection of Human Health and the Environment
Alternative 2 would provide protection to human health. The human health risks from direct contact of contaminated soils and the CSS would be eliminated by a combination of removal and placement of clean fill in Lot 33, coupled with shielding of contamination that is left in place and the use of the radon mitigation system at Lot 42 in the TerraNova building and monitoring in other impacted buildings. Therefore, this alternative would meet the RAOs for soils/solids by reducing human health risks to within EPA's acceptable risk range However, because highly contaminated soil would remain at the site, it would require long-term (i.e., indefinite) monitoring and management, including installation of a radon mitigation system for indoor air if monitoring finds indoor air radon concentrations above the PRGs in other buildings remaining onsite.

Compliance with ARARs
Chemical-specific ARARs identified in **Table 2-1** include NYSDEC Subpart 375-6: Table 375-6.8(b): Unrestricted Use Soil Cleanup Objectives (residential use); 40 CFR Part 192, Memorandum providing updated guidance on "Radiation Risk Assessment at CERCLA Sites: Q & A" (EPA 2014);

A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon (EPA 2012b); and TSCA (40 CFR Part 761.61 – PCB Remediation Waste). The ARARs would be met by the combination of removal and offsite disposal of contaminated soils, building, and CSS debris; the placement of shielding over contaminated soils that remain in place; and the use of radon mitigation systems in impacted buildings.

Site activities and remedy would be designed to meet location- and action-specific ARARs identified in **Tables 2-2 and 2-3**.

Long-Term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil from Lot 33 and replacing with clean fill; (2) installing shielding above contaminated soils in other impacted lots; and (3) removing and replacing impacted portions of the CSS; and (4) implementing radon mitigation measures in impacted buildings. However, highly contaminated soil would remain onsite that would require long-term monitoring and management. If the residual soil gets disturbed, the residual risks would be above EPA's acceptable risk range

An environmental easement would be used to minimize disturbance of the clean fill and intrusive work that may result in direct contact with contaminated soils remaining under buildings, installed shielding or under clean fill used to replace excavated soils.

The adequacy and reliability of this alternative in eliminating residual risks would be dependent on the reliability of maintaining the thickness of the clean fill over the contamination left in place and implementation of administrative controls and environmental easement. In a highly urban urea that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, long-term effectiveness and permanence would be dependent on adherence to controls by a range of entities, some of which likely have minimal or no experience in managing exposures or waste materials identified at this Site. Because the radioactive half-life of Th-232 is 14 billion years, the institutional controls would need to be managed in perpetuity. Ensuring such controls remain effectively in place can be difficult.

Inspection, maintenance, and monitoring would provide adequate and reliable controls to evaluate long-term effectiveness and would ensure that the remedy would remain protective of human health and the environment as designed.

Reduction of T/M/V through Treatment

Currently there are no proven and cost-effective treatment technologies for radioactive wastes. Debris and soils removed for offsite disposal would be disposed in landfills approved for disposal of radioactive wastes. This alternative would not meet the statutory preference for treatment as a principal element of the remedial action, although the clean fill over the contamination left in place and shielding would reduce gamma radiation and mobility of radon and thoron gas.

Short-Term Effectiveness

Alternative 2 would require heavy construction activities that could potentially impact the community, however, employing appropriate health and safety protocols and exercising sound engineering practices would protect the community. Planning for short-term impacts caused by heavy constructions activities, such as street closures and disruption to utility services would need to be implemented to minimize impact to local businesses and residents to the extent possible. Additional impacts include the need to temporarily relocate them during remediation under Alternative 2.

Building demolition and excavation of contaminated soil and contaminated portions of the CSS would provide an immediate reduction in the volume of contaminated material at the site; however, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased during building demolition and excavation activities. These short-term risks would be mitigated using shielding, remote operations, excavators and backhoes with supplied air cabs, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.

Short-term impacts to workers and the community would also include increased truck traffic and noise levels associated with the use of heavy equipment, which could be mitigated effectively and reliably through safety measures and ECs such as defining specific travel routes to/from the site for waste transportation vehicles and coordinating shipments to avoid peak travel hours. The number of truckloads of excavated material to be transported offsite would be approximately 1,400 truckloads for Alternative 2.

Personal protective equipment (PPE) would be required to protect workers during onsite construction activities. Workers would follow the as low as reasonably achievable (ALARA) principles to minimize exposures. This and other potential impacts to workers would be mitigated through adherence to safety plans and standard operating procedures.

It is estimated that construction duration and time to achieve protection would be approximately 1 year and 3 months. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

Implementability

Alternative 2 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials under Alternative 2 and the implementation of institutional controls needed for Alternative 2 would be relatively easy to implement. Alternative 2 would be administratively feasible, although it would require significant administrative coordination efforts. Excavation work and institutional controls would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, some of which may have minimal or no experience in managing exposures or waste materials of the type identified at the Site. Because of the long radioactive half-life of Th-232, the institutional controls would need to be managed in perpetuity. Ensuring such controls remain effectively in place as well as ensuring sufficient building access to complete all components of the alternative may be difficult.

To minimize disruptions and short-term risk to the community, it is anticipated that a phased approach would be employed for this alternative. Construction could be completed using conventional heavy-construction equipment and services, which are readily available in the commercial market. For the excavation and offsite disposal component of the alternative, sloping and benching for excavations, excavation of contaminated soil, and backfill with clean soil could be easily conducted; however, seasonal conditions, such as significant rainfall, could impact construction in progress, and landfills with sufficient capacity to accept the various categories of debris and soil waste (i.e., radioactive waste, radioactive waste mixed with hazardous and/or TSCA bulk remediation waste) to be removed from the site would need to be identified. For cost estimating purposes, potential landfills have been identified.

Cost

A summary of the capital, O&M, and present value costs associated with Alternative 2 is listed below. Detailed analysis cost estimates are presented in **Appendix F**. Note that costs for pre-design and design work are considered separately and are not included in the totals below. In addition, while a 30-year duration is assumed for cost comparison purposes, the actual monitoring/maintenance period for this alternative would be indefinite. In terms of the impact on costing, discounted values of even large costs incurred far in the future tend to be negligible (EPA 2000). As an example, for a 200-year project with constant annual costs of $500,000 at 7%, 99.9% of the discounted O&M costs are incurred in the first 100 years, 97% in the first 50 years, and 88% in the first 30 years (EPA 2000). Therefore, the difference between discounted costs for the 30-year period presented in the FS and the actual indefinite period of performance would be negligible.

- Estimated Total Capital Costs: $34.9 million (M)
- Estimated Total O&M Costs: $1.4 M
- Present Value Total Estimated Costs: $36.2 M (over 30 years)

4.2.3 Alternative 3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls

Remedial Alternative Component Descriptions

The major components of Alternative 3 are described in Section 3.2.2.3. The components include demolition of the WACC buildings, excavation of soils as indicated in **Figure 3-4**, sewer line excavation, replacement and flushing via jet cleaning as described in Section 3.2.1.1, long-term monitoring and maintenance, and establishment of an environmental easement.

Overall Protection of Human Health and the Environment

Alternative 3 would provide protection to human health. The human health risks from direct contact of contaminated soils and the CSS would be reduced by a combination of excavation of contaminated soils exceeding PRGs and placement of clean fill, along with ICs specifying the use of radon mitigation systems in future structures that might be constructed on lots constituting the former WACC facility. Therefore, this alternative would meet the RAOs for soils and solids by reducing human health risks to within EPA's acceptable risk range; however, it would require long-term monitoring and management, including installation of a radon mitigation system for indoor air if a building is constructed on top of the contaminated soil that would remain at the site, as well as management of ICs in perpetuity.

Compliance with ARARs

Chemical-specific ARARs identified in **Table 2-1** and listed in Section 4.2.2 would be met by the combination of removal and offsite disposal of contaminated soils, building, and CSS debris; and ICs requiring the use of radon mitigation systems in structures constructed on lots constituting the former WACC facility.

Site activities and remedy would be designed to meet location- and action-specific ARARs identified in **Tables 2-2 and 2-3**.

Long-Term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil and replacing with clean fill; (2) removing and replacing impacted portions of the CSS; and (3) using ICs to require the installation and use of radon mitigation measures in impacted buildings. However, highly contaminated soil would remain onsite that would require long-term monitoring and management. If the residual soil gets disturbed, the residual risks would be above EPA's acceptable risk range. Therefore, the adequacy and reliability of this alternative in eliminating residual risks would be dependent on the reliability of maintaining the thickness of the clean fill over the contamination left in place as well as implementation of administrative controls and implementation of ICs related to future construction. In a highly urban urea that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, long-term effectiveness and permanence would be dependent on adherence to controls by a range of entities, some of which likely have minimal or no experience in managing exposures or waste materials identified at this Site. Because the radioactive half-life of Th-232 is 14 billion years, the institutional controls would need to be managed in perpetuity. Ensuring such controls remain effectively in place can be difficult.

Reduction of T/M/V through Treatment

Currently there are no proven and cost-effective treatment technologies for radioactive wastes. Debris and soils removed for offsite disposal would be disposed in landfills approved for disposal of radioactive wastes. This alternative would not meet the statutory preference for treatment as a principal element of the remedial action, although the clean fill over the contamination left in place would reduce gamma radiation and mobility of radon and thoron gas.

Short-Term Effectiveness

Alternative 3 would require heavy construction activities that could potentially impact the community, however, employing appropriate health and safety protocols and exercising sound engineering practices would protect the community. Planning for short-term impacts caused by heavy constructions activities, such as street closures and disruption to utility services would need to be implemented to minimize impact to local businesses and residents to the extent possible. Additional impacts include the need to permanently relocate several businesses.

Like Alternative 2, building demolition and excavation of contaminated soil and contaminated portions of the CSS completed under Alternative 3 would provide an immediate reduction in the volume of contaminated material at the site. However, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased over Alternative 2 due to more buildings being demolished and increased excavation activities. These short-term risks would be mitigated using shielding, remote operations, excavators and backhoes with supplied air cabs, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.

As with Alternative 2, short-term impacts to workers and the community would also include increased truck traffic and noise levels associated with the use of heavy equipment, which could be mitigated effectively and reliably through safety measures and ECs such as defining specific travel routes to/from the site for waste transportation vehicles and coordinating shipments to avoid peak travel hours. The number of truckloads of excavated material to be transported offsite would be approximately 1,600 truckloads for Alternative 3.

PPE would be required to protect workers during onsite construction activities. Workers would follow the ALARA principles to minimize exposures. This and other potential impacts to workers would be mitigated through adherence to safety plans and standard operating procedures.

It is estimated that construction duration and time to achieve protection would be approximately 1 year and 4 months. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

Implementability

Alternative 3 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials and the implementation of institutional controls needed for Alternative 3 would be relatively easy to implement. Alternative 3 would be administratively feasible, although it would require significant administrative coordination efforts. Excavation work and institutional controls would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, some of which may have minimal or no experience in managing exposures or waste materials of the type identified at the Site. Because of the long radioactive half-life of Th-232, the institutional controls would need to be managed in perpetuity. Ensuring such controls remain effectively in place as well as ensuring sufficient building access to complete all components of the alternative may be difficult.

To minimize disruptions and short-term risk to the community, it is anticipated that a phased approach would be employed for this alternative. Construction could be completed using conventional heavy-construction equipment and services, which are readily available in the commercial market. For the excavation and offsite disposal component of the alternative, sloping and benching for excavations, excavation of contaminated soil, and backfill with clean soil could be easily conducted; however, seasonal conditions, such as significant rainfall, could impact construction in progress, and landfills with sufficient capacity to accept the various categories of debris and soil waste (i.e., radioactive waste, radioactive waste mixed with hazardous and/or TSCA bulk remediation waste) to be removed from the site would need to be identified. For cost estimating purposes, potential landfills have been identified.

Cost

A summary of the capital, O&M, and present value costs associated with Alternative 3 is listed below. Detailed analysis cost estimates are presented in **Appendix F**. Note that costs for pre-design and design work are considered separately and are not included in the totals below. In addition, while a 30-year duration is assumed for cost comparison purposes, the actual monitoring/maintenance period for this alternative would be indefinite. In terms of the impact on costing, as noted for Alternative 2, discounted values of even large costs incurred far in the future tend to be negligible (EPA 2000); therefore, the difference between discounted costs for the 30-year period presented in the FS and the actual indefinite period of performance would be negligible.

- Estimated Total Capital Costs: $33.5M
- Estimated Total O&M Costs: $745,000
- Present Value Total Estimated Costs: $34.2 M (over 30 years)

4.2.4 Alternative 4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal

Remedial Alternative Component Descriptions

The major components of Alternative 4 are described in Section 3.2.2.4. The components include demolition of the WACC buildings, excavation of soils as indicated in **Figure 3-5**, and sewer line excavation and replacement and flushing via jet cleaning as described in Section 3.2.1.1.

Overall Protection of Human Health and the Environment

Alternative 4 would provide protection to human health and the environment and meet RAOs for soils and solids as well as future buildings that might be constructed on the Site. The human health risks from direct contact of contaminated soils and the CSS would be eliminated by a combination of removal of soils, including all PTW soils and materials exceeding PRGs and placement of clean fill in excavated area.

Compliance with ARARs

Chemical-specific ARARs identified in **Table 2-1** and listed in Section 4.2.2 would be met by the combination of removal and offsite disposal of contaminated soils, building, and CSS debris; and placement of clean fill in excavated areas.

Site activities and remedy would be designed to meet location- and action-specific ARARs identified in **Tables 2-2 and 2-3**.

Long-Term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil and replacing with clean fill; and (2) removing and replacing impacted portions of the CSS. The residual risks would be within EPA's acceptable risk range. Excavation and off-site disposal is reliable and is not reversible.

Reduction of T/M/V through Treatment

Currently there are no proven and cost-effective treatment technologies for radioactive wastes. Debris and soils removed for offsite disposal would be disposed in landfills approved for disposal of radioactive wastes. This alternative would not meet the statutory preference for treatment as a principal element of the remedial action,

Short-Term Effectiveness

Alternative 4 would require heavy construction activities that could potentially impact the community, however, employing appropriate health and safety protocols and exercising sound engineering practices would protect the community. Planning for short-term impacts caused by heavy constructions activities, such as street closures and disruption to utility services would need to be implemented to minimize impact to local businesses and residents to the extent possible. Additional impacts include the need to permanently relocate several businesses.

Like Alternative 3, building demolition and excavation of contaminated soil and contaminated portions of the CSS completed under Alternative 4 would provide an immediate reduction in the volume of contaminated material at the site. However, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased over Alternative 4 due to increased excavation activities. These short-term risks would be mitigated using shielding, remote operations, excavators and backhoes with supplied air cabs, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.

As with Alternatives 2 and 3, short-term impacts to workers and the community would also include increased truck traffic and noise levels associated with the use of heavy equipment, which could be mitigated effectively and reliably through safety measures and ECs such as defining specific travel routes to/from the site for waste transportation vehicles and coordinating shipments to avoid peak travel hours. The number of truckloads of excavated material to be transported offsite would be approximately 1,900 truckloads for Alternative 4.

Personal protective equipment (PPE) would be required to protect workers during onsite construction activities. Workers would follow the ALARA principles to minimize exposures. This and other potential impacts to workers would be mitigated through adherence to safety plans and standard operating procedures.

It is estimated that construction duration and time to achieve protection would be approximately 1 year and 6 months. The estimated duration is based on construction activity production rates. The actual duration may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

Implementability

Alternative 4 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials under Alternative 4. Alternative 4 would be administratively feasible, although it would require significant administrative coordination efforts. Excavation work would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure, including gas and electric lines, water mains, cable and telephone lines. The excavation work would impose additional engineering and structural requirements that are disruptive to the public and may result in longer construction periods. Utilities may need to be removed and temporarily relocated. In addition, excavation work may require structural supports such as the underpinning of adjacent buildings to temporarily support foundations during excavation and shoring for worker safety. To minimize disruptions and short-term risk to the community, it is anticipated that a phased approach would be employed for this alternative. Construction could be completed using conventional heavy-construction equipment and services, which are readily available in the commercial market. For the excavation and offsite disposal component of the alternative, sloping and benching for excavations, excavation of contaminated soil, and backfill with clean soil could be easily conducted; however, seasonal conditions, such as significant rainfall, could impact construction in progress, and landfills with sufficient capacity to accept the various categories of debris and soil waste (i.e., radioactive waste, radioactive waste mixed with hazardous and/or TSCA bulk remediation waste) to be removed from the site would need to be identified. For cost estimating purposes, potential landfills have been identified.

Cost

A summary of the detailed analysis capital, O&M, and present value costs associated with Alternative 4 is listed below. Detailed analysis cost estimates are presented in **Appendix F**. Note that costs for pre-design and design work are considered separately and are not included in the totals below.

- Estimated Total Capital Costs: $39.4 M
- Estimated Total O&M Costs: $0
- Present Value Total Estimated Costs: $39.4 M

4.3 Comparative Analysis of Remedial Alternatives

Comparative analysis of the four remedial alternatives is presented in narrative form in the following subsections. The comparative analysis exercise evaluates the four retained alternatives in relation to one another for the two threshold and five balancing criteria. The purpose is to identify relative advantages and disadvantages of each alternative. Only significant comparative differences between alternatives are presented. A summary of the comparative analysis is presented in **Table 4-1**.

4.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold criterion that must be met. Alternative 4 would achieve RAOs and protection of human health and the environment by removing contaminated soil, CSS, and building materials above the PRGs from the site. The residual risks would be within EPA's acceptable risk range. Alternatives 2 and 3 also would achieve RAOs and protection of human health by excavation and off-site disposal of contaminated shallow soil and backfill with clean fill in combination with long-term management and institutional controls. Alternative 1 would not be protective of human health and the environment as the contaminated soil and buildings would remain unchanged.

4.3.2 Compliance with ARARs

Compliance with ARARs is a threshold criterion that must be met. Because no action would be taken under Alternative 1, the presence of unaddressed contaminated soil would not meet chemical-specific ARARs. Alternatives 2, 3 and 4 would meet the chemical-specific ARARs identified in **Table 2-1** and listed in Section 4.2.2 by various means. Alternative 2 would meet the ARARs with a combination of removal and offsite disposal of shallow contaminated soils, building, and CSS debris; placement of shielding over contaminated soils under WACC buildings that would remain in place; and the use of radon mitigation systems in impacted buildings. Alternative 3 would meet the ARARs with a combination of removal and offsite disposal of shallow contaminated soils, building, and CSS debris; placement of a soil cover over contaminated soils that remain in place; long-term maintenance of the soil cover, and implementation of ICs to protect the integrity of the soil cover and require the use of radon mitigation systems if buildings are constructed on the WACC site in the future. Alternative 4 would meet the ARARs through removal and offsite disposal of contaminated soils, building, and CSS debris.

Site activities for Alternatives 2 through 4 would be designed to meet location- and action-specific ARARs identified in **Tables 2-2 and 2-3**.

Note: the remaining criteria are modifying criteria and not threshold criteria

4.3.3 Long-Term Effectiveness and Permanence

Alternative 4 would provide the highest degree of long-term protectiveness and permanence because contaminated building materials and CSS debris and contaminated soils above the PRGs would be removed from the site. Alternative 2 would provide long-term effectiveness and permanence for the buildings that would remain in place. Long-term effectiveness and permanence would rely on the maintenance of the soil covering the contamination left in place and implementation of ICs to require the use of radon mitigation systems if buildings are constructed on the former WACC property in the future. Alternative 3 would provide a slightly greater degree of long-term effectiveness and permanence than Alternative 2 in that it would leave no WACC buildings in place and would employ shallow excavation and backfill with clean fill in the excavation areas; however, it would still require ICs to limit intrusive activity and allow access for monitoring. Maintaining soil cover and ICs in perpetuity under Alternatives 2 and 3 would be difficult in an urban area in particular. Alternative 1 would provide no long-term effectiveness and permanence because no action would be taken. Risks from the site contaminants would remain the same.

4.3.4 Reduction of Toxicity, Mobility or Volume through Treatment

Because no action would be taken, Alternative 1 would not address this criterion. Alternatives 2 through 4 would not meet the statutory preference for treatment as a principal element of the remedial action. However, no proven and cost-effective treatment technology is currently available to treat radioactive wastes.

4.3.5 Short-Term Effectiveness

Alternative 1 would not have any impacts to the community and workers because no action would be taken. Alternatives 2-4 all would require heavy construction activities that could potentially impact the community, however, employing appropriate health and safety protocols and exercising sound engineering practices would protect the community. Planning for short-term impacts caused by heavy constructions activities, such as street closures and disruption to utility services would need to be implemented to minimize impact to local businesses and residents to the extent possible. Additional impacts include the need to permanently relocate several businesses under Alternatives 3 and 4, and temporarily relocate them during remediation under Alternative 2.

Alternative 4 would require the largest amount of space to effectively carry out all components of the alternative (i.e., building demolition, excavation, staging, CSS removal and replacement, and backfill operations) because it involves the largest amount of demolition and excavation. As a result, Alternative 4 would likely cause the greatest level of short-term risk to the community and potential impact to workers due to the need to safely manage and conduct these operations in limited space and constrained areas. Alternatives 2 -4 all would involve heavy construction activities that would require implementation of dust control measures, stormwater run-on and runoff control, and measures to mitigate noise impact on the community. In addition, air monitoring would be required to reduce risks to workers and the community from fugitive emissions during construction and remediation. Potential risk to remediation workers associated with direct exposure to contaminated material would be mitigated through the use of PPE and standard ALARA principles. Alternative 3 is similar to Alternative 4 but would cause somewhat less short-term risk to the community and potential impact to workers because less soil would be excavated from under the demolished buildings on the WACC site. Under Alternative 2, only the warehouse on Lot 33 would be demolished and would only involve shallow excavation; therefore, there would be less impact to the community and workers due to demolition and excavation.

Finally, Alternatives 2 through 4 all require the off-site transport of contaminated soil and on-site transport of clean backfill, which may pose an increased risk for traffic accidents which in turn could result in the release of hazardous substances. However, a traffic control plan would be developed to mitigate adverse impacts to traffic. The number of truckloads of excavated material to be transported offsite range from approximately 1,400 truckloads for Alternative 2 to 1,900 truckloads for Alternative 4.

The durations estimated for the alternatives to achieve protection and RAOs are:

Alternative 1: would not achieve RAOs

Alternative 2: approximately 1 year and 3 months

Alternative 3: approximately 1 year and 4 months

Alternative 4: approximately 1 year and 5 months

These durations are estimated and based on construction activity production rates. Actual durations may be longer because of logistical constraints such as obtaining permits, awaiting inspections, awaiting confirmation sample results before backfilling, or other possible delays in schedule. As a result, the duration for the completion of the construction phase of the remediation action could potentially range from 2 to 3 years.

4.3.6 Implementability

Alternative 1 would be the easiest to implement since it involves no action. The remaining alternatives, to varying degrees, all would have implementability issues related to excavation work. This is due in part not only to the nature of the activities that would be conducted for each alternative, but also because those activities would be implemented in an urban setting with many physical constraints that present significant implementation challenges.

Although the total volume of material to be excavated under Alternative 2 is less than the other alternatives, the targeted demolition and excavation of Lot 33, coupled with the placement of shielding in the other WACC site buildings, would likely make Alternative 2 more difficult to implement. This is due to the structural condition of the buildings on the lots adjacent to Lot 33 and the physical constraints present in the area. The demolition of all the WACC buildings that would occur under Alternatives 3 and 4 would make the demolition and excavation components of those alternatives easier to implement than the demolition component of Alternative 2. Excavation work and ICs for Alternatives 2 and 3 would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, some of which may have minimal or no experience in managing exposures or waste materials of the type identified at the Site. Because of the long radioactive half-life of Th-232, the ICs for Alternatives 2 and 3 would need to be managed in perpetuity. Conversely, Alternatives 2-4 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials under these alternatives and the implementation of institutional controls needed for Alternatives 2 and 3 would be relatively easy to implement. Alternatives 2-4 all would be administratively feasible, although all three alternatives would require significant administrative coordination efforts.

4.3.7 Cost

Detailed cost estimates presented in **Appendix G** are expected to have an accuracy range of –30 percent to +50 percent (EPA 2000). The detailed analysis level accuracy range of –30 percent to +50 percent means that, for an estimate of $100,000, the actual cost of an alternative is expected to be between $70,000 and $150,000 (EPA 2000). A comparison of alternative costs is presented below.

Alternative	Estimated Capital Costs[1]	Total O&M Cost[2]	Total Present Worth
1 – No Further Action	$0	$0	$0
2 – Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs	$34.4M	$1.4M	$36.2M
3 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and ICs	$33.5M	$745,000	$34.2M
4 – Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal	$39.4M	$0	$39.4M

1 Capital costs include contingency.
2 Discount factor is calculated using an interest rate of 7% applied over the duration of O&M and long-term monitoring for the alternative. O&M duration for Alternative 1 and Alternative 4 is zero years. In accordance with EPA guidance, the O&M and long-term monitoring cost for Alternative 2 and 3 is estimated using a duration of 30 years.

No costs are estimated for Alternative 1 as no action would be taken.

Alternative 4, which involves the excavation and offsite disposal of all contaminated soils exceeding PRGs, has the highest present value ($39.4M), but would result in the elimination of all the PTW. No annual or periodic costs would be incurred under Alternative 4. Alternative 2, which limits excavation to shallow soils exceeding PRGs and requires installation of shielding has the next highest present value ($34.4M). The total O&M costs for Alternative 2 are $1.4M over a 30-year period.

With an estimated total present worth cost of $33.5M, Alternative 3 has the lowest present worth value. The total O&M costs for Alternative 3 are $745,000 over a 30-year period.

4.4 Sensitivity Analysis of Remedial Alternatives

A sensitivity analysis was performed to study the change in capital costs with respect to the change in production rates and the change in the volume of TSCA and radiologically-contaminated material. The analysis was only performed for Alternative 4 because production costs and disposal costs would be most sensitive for Alternative 4 since it has the highest volume of excavated soil. Other alternatives are expected to have a lower sensitivity due to the changes in production rates and waste volume. The change in capital costs for Alternative 4 was determined for the following scenarios:

- Scenario 1 – A decrease in radiological waste volumes by 20% with a total waste volume held constant

- Scenario 2 – All waste would be considered radiological waste. Additionally, the volume of TSCA/radioactive combined waste is highly uncertain since the volume is estimated based on one data point. For this scenario, the TSCA/radioactive combined waste volumes would be increased from 80 tons to 500 tons, with the total waste volume held constant

- Scenario 3 – A decrease of production rates for all construction activities by 20% due to site specific constraints

The summary of this analysis is provided in **Table 4-2**. Results show that:

- Scenario 1 - For a 20% decrease in radiological waste volumes, the total capital costs would change from $39.4 million to $35.8 million, a decrease of $3.6 million or -9%

- Scenario 2 – If all wastes are considered radioactive waste and an increase in volume of TSCA/radioactive combined waste, the total capital costs would change from $39.4 million to $40.4 million, an increase of $1 million or 3%.

- Scenario 3 - If production rates are decreased by 20%, the total capital costs would change from $39.4 million to $42.1 million, an increase of $2.7 million or 7%

This analysis illustrates that, if the total volume of waste remains constant, the total capital costs are more sensitive to the changes in production rates or the decrease in radioactive waste volume and less sensitive to the increase in radioactive waste volume. The smaller change in total capital costs under Scenario 2 is due to smaller volume changes (compared to Scenarios 1 and 3), since most of the wastes have been assumed to be radioactive wastes in the baseline scenario.

Section 5

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Tables

Table 2-1
Potential Chemical-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARAR	Status	Requirement Synopsis	Comments
Federal	Uranium Mill Tailings Radiation Control Act (UMTRCA): Cleanup of Radioactively Contamination Land Contaminated Buildings (40 CFR Part 192)	Relevant and Appropriate	Residual radioactive material concentration of Ra-226 and Ra-228 in land averaged over 100 square meter area shall not exceed the background level by >5 pCi/g. Indoor radon should not exceed 0.02 WL.	Because the site was not a uranium ore processing facility, this standard is not applicable. However, it is relevant and appropriate in conjunction with OSWER Directive 9200.4-25 discussed below.
Federal	Protection of The General Population from Releases of Radioactivity 10 CFR Part 61.41	Applicable	Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.	Activities that potentially impact include excavation and transport of contaminated soil offsite, covers over contaminated soil areas, and construction of restrictive physical barriers such as fencing.
Federal	OSWER Directive 9200.4-25, Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites.	To Be Considered	Provides guidance regarding the circumstances under which subsurface soil cleanup criteria in 40 CFR Part 192 should generally be consdered an applicable or relevant and appropriate requirement for radion and thorium in developing a response action under CERCLA.	The guidance was used to develop PRGs for radioactive contamination in solids.
Federal	OWSER Directive 9200.4-18, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.	To Be Considered	Provides clarifying guidance for establishing protective cleanup levels for radioactive contamination at CERCLA sites.	The guidance was used to develop PRGs for radioactive contamination in solids.

Table 2-1
Potential Chemical-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARAR	Status	Requirement Synopsis	Comments
Federal	OSWER Directive 9285.6-20, Radiation Risk Assessment at CERCLA Sites: Q&A	To Be Considered	Presents an overview of current EPA guidance for risk assessment and related topics for radioactively contaminated CERCLA remedial sites.	The guidance was used in the development of PRGs for radioactive contamination at the site.
Federal	Radiological criteria for unrestricted use 10 CFR 20.1402	Relevant and appropriate	Presents a radiological criteria for unrestricted use for a property	Because the site is not under jurisdiction of the Nuclear Regulatory Comission, this guidance is not applicable. However, it is relevant and appropriate for radioactive contamination at the site.
Federal	A Citizen's Guide to Radon (EPA402/K-12/002)	To Be Considered	Provides a generally recommended cleanup level for radon concentrations in indoor air for default target risk levels and exposure scenarios.	The guidance was used to develop screening criteria for radon in indoor air.
Federal	Toxic Substance Control Act (TSCA) 40 CFR Part 761.61 – PCB Remediation Waste	Applicable	Establishes cleanup and disposal options for PCB remediation waste.	The regulation was used to establish the cleanup levels for bulk PCB remediation waste.
State	NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Residential Use Soil Cleanup Objectives	Applicable	Establishes standards for soil cleanups. Restricted residential use standards for site COCs: Aroclor 1260 - 1 ppm Benzo(a)pyrene - 1 ppm	The standards was used to develop the PRGs.

Notes:
The potential ARARs and TBCs identified in this table are preliminary and subject to revision during legal review.
ARAR - applicable or relevant and appropriate requirement
UMTRCA - Uranium Mill Tailings Radiation Control Act
CFR - Code of Federal Regulations
pCi/g - picoCuries per gram
OSWER - Office of Solid Waste and Emergency Response
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Action
PRGs - Preliminary remediation goals
TSCA - Toxic Substances Control Act
PCB - poly chlorinated biphenyls

Table 2-2
Potential Location-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Comments
Wildlife Habitat Protection Standards and Regulations				
Federal	Endangered Species Act (16 U.S.C. 1531 et seq.; 40 CFR 400)	Applicable	This requirement establishes standards for the protection of threatened and endangered species.	The site is in a highly industrialized area which a majority of the site covered by buildings, cement, and pavement. No critical habitats are within the project area. Site activities and remedy would be designed and implemented in a manner that protects and conserves threatened or endangered species if they are observed on site.

Notes:
The potential ARARs and TBCs identified in this table are preliminary and subject to revision during legal review.
ARAR - applicable or relevant and appropriate requirement
CFR - Code of Federal Regulations

Table 2-3
Potential Action-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Comments
	General Site Remediation			
Federal	RCRA Identification and Listing of Hazardous Wastes (40 CFR 261)	Applicable	This regulation describes methods for identifying hazardous wastes and lists known hazardous wastes.	This regulation is applicable to the identification of hazardous wastes that are generated, treated, stored, or disposed during remedial activities.
Federal	RCRA Standards Applicable to Generators of Hazardous Wastes (40 CFR 262)	Applicable	Describes standards applicable to generators of hazardous wastes.	Standards will be followed if any hazardous wastes are generated on site.
Federal	RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities – General Facility Standards (40 CFR 264.10–264.19)	Relevant and Appropriate	This regulation lists general facility requirements, including general waste analysis, security measures, inspections, and training requirements.	Facility will be designed, constructed, and operated in accordance with this requirement. All workers will be properly trained.
Federal	RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities – Preparedness and Prevention (40 CFR 264.30–264.37)	Relevant and Appropriate	This regulation outlines the requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site. Local authorities will be familiarized with the site.
Federal	RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities – Contingency Plan and Emergency Procedures (40 CFR 264.50–264.56)	Relevant and Appropriate	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, or other emergencies.	Emergency procedure plans will be developed and implemented during remedial action. Copies of the plans will be kept on site.
Federal	Protection of The General Population from Releases of Radioactivity 10 CFR Part 61.41	Applicable	Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.	Activities that potentially impact include excavation and tranmsport of contaminated soil offsite, covers over contaminated soil areas, and construction of restrictive physical barriers such as fencing.
Federal	OSWER Directive 9200.1-33P, Headquarters Consultation for Radioactively Contaminated Sites	To Be Considered	This memorandum requests that EPA Regional offices consult with Headquarters on CERCLA response decisions involving on-site management of radioactive materials (e.g., capping of material in place, building disposal cells) or when there is a potential national precedent-setting issue related to a radioactive substance, pollutant or contaminant.	Any deviation from the regional approach to radiological contamination would require consultation with EPA headquarters as it may be precedent setting.

Table 2-3
Potential Action-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Comments
Federal	Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)	To Be Considered	This document provides detailed guidance on how to demonstrate that a site is in compliance with a radiation dose- or risk-based regulation. MARSSIM focuses on the demonstration of compliance during the final status survey following scoping, characterization and any necessary remedial actions.	The final status survey will be conducted in accordance with MARSSIM.
State	New York Technical Guidance for Site Investigation and Remediation	To Be Considered	This guidance provides an overview of the site investigation and remediation process and the minimal technical requirements to investigate and remediation contamination at the site.	The regulation will be applied to any site operations during remediation of the site.
State	New York Uniform Construction Code (19 NYCRR)	Applicable	This code provides the requirement for construction performed during remediation of the site.	This code will be applied to any construction performed during remediation of the site.
State	New York Hazardous Waste Management Regulations - Identification and Listing of Hazardous Waste (6 NYCRR Part 371)	Applicable	This regulation describes methods for identifying hazardous wastes and lists known hazardous wastes.	This regulation will be applicable to the identification of hazardous wastes that are generated, treated, stored, or disposed during remedial activities.
State	New York State Standards and Specifications for Erosion and Sediment Control (Blue Book)	Applicable	This provides standards and specifications for the selection, design, and implementation of erosion and sediment control practices for the development of Erosion and Sediment Control Plans for the SPDES General Permit for Stormwater Discharges from Construction Activity.	This act will be considered during the development of alternatives.
	Waste Transportation			
Federal	Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171, 172, 173, 177 to 179)	Applicable	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting hazardous materials.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
Federal	RCRA Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	Applicable	Establishes standards for hazardous waste transporters.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
State	Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities (6 NYCRR Part 372)	Applicable	Establishes standards for generators and transporters of hazardous wate and standards for generators, transporters, and treament, storage, and disposal facilities relating to the use of the manifest system and its recordkeeping requirements.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
State	Waste Transporter Permit Program (6 NYCRR Part 374)	Applicable	Outlines specific requirements for persons transporting regulated waste.	Any company contracted to transport hazardous material from the site must possess a valid New York State Part 364 Waste Transporter Permit.

Table 2-3
Potential Action-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Comments
	Waste Disposal			
Federal	Nuclear Waste Policy Act of 1982	Applicable	This act establishes a comprehensive national program for safe and permanent disposal of highly radioactive wastes.	Radioactive waste will be treated or disposed of to meet the regulatory requirements.
Federal	TSCA Disposal of PCB Bulk Product Waste (40 CFR Part 761.62)	Applicable	This regulation identifies treatment and disposal requirements for bulk PCB contaminated waste.	Bulk PCB waste will be treated or disposed of to meet the regulatory requirements.
Federal	RCRA Land Disposal Restrictions (40 CFR 268)	Applicable	This regulation identifies hazardous wastes restricted for land disposal and provides treatment standards for land disposal.	Hazardous wastes will be treated to meet disposal requirements.
Federal	RCRA Hazardous Waste Permit Program (40 CFR 270)	Applicable	This regulation establishes provisions covering basic EPA permitting requirements.	All permitting requirements of EPA must be complied with.
Federal	Area of Contamination (55FR 8758-8760, March 8, 1990	Applicable	These regulations establish rules for consolidation of contiguous waste within an Area of Contamination.	Hazardous wastes may be consolidated and contained within a specific area based on these rules.
Federal	Corrective Action Management Units (Subpart S of 40 CFR 264.552)	Applicable	These regulations provide exceptions to LDR requirements and establish rules for consolidation and treatment of noncontiguous waste within a site.	Hazardous wastes that are noncontiguous may be consolidated and contained within the same area at a different location.
State	New York Standards for Universal Waste (6 NYCRR Part 374-3)	Applicable	This regulation establishes requirements for managing universal waste including batteries, pesticides, thermostats, and lamps.	All remedial activities must adhere to these regulations while handling waste during remedial operations.
State	Land Disposal Restrictions (6 NYCRR Part 376)	Applicable	This regulation identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may be land disposed.	All remedial activities must adhere to these regulations while handling hazardous waste during remedial operations.
	Water Discharge or Subsurface Injection			
Federal	Federal Water Pollution Control Act (33 U.S.C. §1251, et seq., as amended by the Clean Water Act) and Implementing Regulations; 40 CFR Part 131	Applicable	Sets criteria for water quality based on toxicity to aquatic organisms and human health. States granted enforcement jurisdiction over direct discharges and may adopt reasonable standards to protect or enhance uses and qualities of surface water bodies in the states.	Remedial activities must be consistent with regional water quality management and avoid adverse impact to Newton Creek.
State	New York State Pollutant Discharge Elimination System (6 NYCRR Part 750-757)	Applicable	This permit governs the discharge of any wastes into or adjacent to State waters that may alter the physical, chemical, or biological properties of State waters, except as authorized pursuant to a SPDES or State permit.	Project will meet SPDES permit requirements for surface discharges or groundwater discharge.

Table 2-3
Potential Action-Specific ARARs, Criteria, and Guidance
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Comments
	Off-Gas Management			
Federal	Clean Air Act (CAA)—National Ambient Air Quality Standards (NAAQs) (40 CFR 50)	Applicable	These provide air quality standards for particulate matter, lead, nitrogen dioxide, sulfur dioxide, carbon monoxide, and volatile organic matter.	During excavation, treatment, and/or stabilization, air emissions will be properly controlled and monitored to comply with these standards.
Federal	Standards of Performance for New Stationary Sources (40 CFR 60)	Applicable	Set the general requirements for air quality.	During excavation, treatment, and/or stabilization, air emissions will be properly controlled and monitored to comply with these standards.
Federal	National Emission Standards for Hazardous Air Pollutants (40 CFR 61)	Applicable	These provide air quality standards for hazardous air pollutants .	During excavation, treatment, and/or stabilization, air emissions will be properly controlled and monitored to comply with these standards.
State	New York Permits and Regulations (6 NYCRR Part 201)	Applicable	Establishes the requirement of owners and operations of air contamination sources to obtain a permit or registration from the department fo the construction and operation of such sources.	This standard will be applied if off-gassing is required for an alternative.
State	New York General Prohibitions (6 NYCRR Part 211)	Applicable	Prohibits air pollution and limits visible emissions.	This standard will be applied to any remediation activities performed at the site.
State	New York Air Quality Standards (6 NYCRR Part 257)	Applicable	Establishes air quality standards to provide protection from the adverse health effects of air contamination and to protect and conserve the natural resources and environment.	This standard will be applied to any remediation activities performed at the site.
State	New York State Department of Environmental Conservation (DAR-1) Air Guide 1, Guidelines for the Control of Ambient Air Contaminants	Applicable	Provides guidance for the control of ambient air contaminants.	This standard will be applied if off-gassing is required for an alternative.

Notes:
The potential ARARs and TBCs identified in this table are preliminary and subject to revision during legal review.
ARAR - applicable or relevant and appropriate requirement
OSHA - Occupational Safety and Health Administration
CFR - Code of Federal Regulations
RCRA - Resource Conservation and Recovery Act
MARSSIM - Multi-Agency Radioation Survey and Site Investigation Manual
NYCRR - New York Codes, Rules, and Regulations
DOT - Department of Transportation
TSCA - Toxic Substances Control Act
PCB - poly chlorinated biphenyls
NAAQs - National Ambient Air Quality Standards

Table 4-1
Summary of Comparative Analysis for Alternatives
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Evaluation Criterion	ALTERNATIVE 1 No Further Action	ALTERNATIVE 2 Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 3 Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 4 Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal
Summary of Alternative Components	-Five-year reviews	-Temporary relocation of tenants - Demolition of Warehouse building on Lot 33 - Excavation of contaminated soils exceeding the PRGs down to a maximum of 4 feet in all areas with the exception of soils under remaining buildings in Lots 42, 44, 46 and 48 - Excavation and replacement/jet-cleaning of contaminated sewer pipe - Disposal of building debris, excavated soils, sewer pipe, and sediment in a permitted landfill for radioactive waste - Post-excavation sampling - Installation of lead-shielding within buildings on Lots 42, 44 and 46. - Site Restoration - Maintenance of the radon mitigation system in building in Lot 42 and conduct vapor intrusion monitoring in all buildings after excavation and backfill - Long-term monitoring - Deed notice - Five-year reviews	-Permanent relocation of tenants - Demolition of WACC buildings - Excavation of contaminated soils exceeding the PRGs to depths designated in Figure 3-4. - Excavation and replacement/jet-cleaning of contaminated sewer pipe - Disposal of building debris, excavated soils, sewer pipe, and sediment in a permitted landfill for radioactive waste - Post-excavation sampling - Site Restoration - Long-term monitoring - Deed notice - Five-year reviews	-Permanent relocation of tenants - Demolition of WACC buildings - Excavation of contaminated soils exceeding the PRGs as shown on Figure 3-5. - Excavation and replacement/jet-cleaning of contaminated sewer pipe - Disposal of building debris, excavated soils, sewer pipe, and sediment in a permitted landfill for radioactive waste - Post-excavation sampling - Site Restoration
Overall Protection of Human Health and the Environment	The No Further Action alternative would not protect human health or the environment since contaminated soil, and contamination in the building and the CSS would be left unaddressed and would remain on the site. This alternative would not meet the RAOs.	Alternative 2 would meet the RAOs by reducing human health risks to within EPA's acceptable risk range by reducing human health risks from direct contact of contaminated soils and the CSS would be eliminated by a combination of removal/cleaning of the sewer, removal and placement of clean fill in Lot 33, shielding of contamination that is left in place and the use of radon mitigation systems and monitoring in impacted buildings. RAOs would be achieved in combination with long-term management and institutional controls.	The human health risks from direct contact of contaminated soils and the CSS would be reduced by a combination of removal/cleaning of the sewer, excavation of contaminated soils exceeding PRGs to a maximum of 4 feet and placement of clean fill, along with ICs specifying the use of radon mitigation systems in future structures that might be constructed on lots constituting the former WACC facility. Therefore, this alternative would meet the RAOs by reducing human health risks to within EPA's acceptable risk range, however it would require long-term monitoring and management, including installation of a radon mitigation system if a building is constructed on top of the contaminated soil because highly contaminated PTW soil would remain at the site.	Alternative 4 would provide protection to human health and the environment and meet RAOs. The human health risks from direct contact of contaminated soils and the CSS would be eliminated by a combination of removal/cleaning of the sewer, removal of soils, including all PTW soils and materials exceeding PRGs and placement of clean fill in excavated area.
Compliance with ARARs	The No Action Alternative fails to meet the threshold criterion of compliance with ARARs.	Chemical-specific ARARs include NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives (residential use); 40 CFR Part 192, Memorandum (OSWER 9285.6-20, June 13, 2014) providing updated guidance on "Radiation Risk Assessment at CERCLA Sites: Q & A" (Directive 9200.4-40, EPA 540-R-012-13, May 2014) (EPA 2014); A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon. U.S. EPA/OAR/IED (6609J); EPA 402/K-12/002., and TSCA (40 CFR Part 761.61 – PCB Remediation Waste). The ARARs would be met by the combination of sewer removal/cleaning, removal and offsite disposal of contaminated soils, building and CSS debris, placement of shielding over contaminated soils that remain in place and the use of radon mitigation systems in impacted buildings. Site activities and remedy would be designed to meet location- and action-specific ARARs.	Chemical-specific ARARs would be met by the combination of sewer removal/cleaning, removal and offsite disposal of contaminated soils, building and CSS debris, and ICs requiring the use of radon mitigation systems in structures constructed on lots constituting the former WACC facility. Site activities and remedy would be designed to meet location- and action-specific ARARs.	Chemical-specific ARARs would be met by the combination of sewer removal/cleaning, removal and offsite disposal of contaminated soils, building and CSS debris and placement of clean fill in excavated areas. Site activities and remedy would be designed to meet location- and action-specific ARARs.

Table 4-1
Summary of Comparative Analysis for Alternatives
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Evaluation Criterion	ALTERNATIVE 1 No Further Action	ALTERNATIVE 2 Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 3 Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 4 Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal
Long-Term Effectiveness and Permanence	Because the No Further Action Alternative would not remove, treat, or contain the contaminated soils or CSS, the contamination left in place would continue to pose unacceptable risks to human health through direct exposure to radium and thorium and through inhalation of radon and thoron.	Alternative 2 would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil from Lot 33 and replacing with clean fill; (2) installing shielding above contaminated soils in other impacted lots; (3) removing and replacing or jet-cleaning impacted portions of the CSS; and (4) implementing radon mitigation measures in impacted buildings. However, highly contaminated soil would remain onsite that would require long-term monitoring and management of institutional controls in perpetuity. Ensuring such controls remain effectively in place can be difficult. If the residual soil gets disturbed, the residual risks would be above EPA's acceptable risk range.	This alternative would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil and replacing with clean fill; (2) removing and replacing or jet-claning impacted portions of the CSS; and (3) using institutional controls to require the installation and use of radon mitigation measures in impacted buildings. However, highly contaminated soil would remain onsite that would require long-term monitoring and management of instiutional controls in perpetuity. If the residual soil gets disturbed, the residual risks would be above EPA's acceptable risk range. Therefore, the adequacy and reliability of this alternative would be dependent on the reliability of maintaining the cap (clean fill) and implementation of ICs related to future construction.	This alternative would provide long-term effectiveness and permanence by (1) removing building debris and contaminated soil and replacing with clean fill; and (2) removing and replacing or jet-cleaning impacted portions of the CSS. The residual risks would be within EPA's acceptable risk range.
Reduction of Toxicity, Mobility, or Volume through Treatment	No remedial action would be taken under Alternative 1, thus, there would be no reduction in toxicity, mobility, or volume of contaminated soil or contamination in the CSS. The statutory preference for treatment as a principal element of the remedial action would not be met.	Currently there are no treatment technologies for radioactive wastes. Debris and soils removed for offsite disposal would be disposed in landfills approved for disposal of radioactive wastes. This alternative would not meet the statutory preference for treatment as a principal element of the remedial action.	See Alternative 2.	See Alternative 2.

Table 4-1
Summary of Comparative Analysis for Alternatives
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Evaluation Criterion	ALTERNATIVE 1 No Further Action	ALTERNATIVE 2 Temporary Relocation of Tenants, Targeted Building Demolition, Installation of Additional Shielding, Shallow Soil Excavation, Soil Cover Over Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 3 Permanent Relocation of Tenants, Demolition of WACC Buildings, Shallow Soil Excavation, Soil Cover of Remaining Contamination, Sewer Removal/Cleaning, Off-Site Disposal, and Institutional Controls	ALTERNATIVE 4 Permanent Relocation of Tenants, Demolition of WACC Buildings, Soil Excavation, Sewer Removal/Cleaning, and Off-Site Disposal
Short-Term Effectiveness	There would be no short-term impacts or risks to workers, the community, and the environment from implementation. This alternative would neither minimize nor increase greenhouse gas emissions, air pollutants, energy consumption, or water use because no action would be taken.	Building demolition and excavation of contaminated soil and contaminated portions of the CSS would provide an immediate reduction in the volume of contaminated material at the site; however, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased during building demolition and excavation activities. These short-term risks would be mitigated using shielding, remote operations, air tight excavators and backhoes, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.	Like Alternative 2, building demolition and excavation of contaminated soil and contaminated portions of the CSS completed under Alternative 3 would provide an immediate reduction in the volume of contaminated material at the site. However, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased over Alternative 2 due to more buildings being demolished and increased excavation activities. These short-term risks would be mitigated using shielding, remote operations, air tight excavators and backhoes, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.	Like Alternative 3, building demolition and excavation of contaminated soil and contaminated portions of the CSS completed under Alternative 4 would provide an immediate reduction in the volume of contaminated material at the site. However, the potential for short-term risks to workers and the community due to direct exposures and airborne transport of contaminated materials would be increased over Alternative 4 due to increased excavation activities. These short-term risks would be mitigated using shielding, remote operations, air tight excavators and backhoes, limiting exposure durations, and maintaining a safe distance. Other standard construction practices, such as dust suppression with water or chemicals, foam application, placing a structure over the excavation, or using a vacuum manifold to capture emissions, would also be implemented to minimize generation of dust and air pollutants.
Implementability	Alternative 1 would not involve any administrative or technical implementation issues because no remedial action would be implemented.	Alternative 2 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials and the implementation of institutional controls needed for Alternative 2 would be relatively easy to implement. Alternative 2 would be administratively feasible, although, it would require significant administrative coordination efforts. Excavation work and institutional controls would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure requiring a constant need for street openings by different types of entities, some of which may have minimal or no experience in managing exposures or waste materials of the type identified at the Site. Because of the long radioactive half-life of Th-232, the institutional controls would need to be managed in perpetuity. Ensuring such controls remain effectively in place may be difficult.	See Alternative 2.	Alternative 4 would employ technologies known to be reliable and that can be readily implemented; and equipment, services, and materials needed for these alternatives are readily available. In addition, sufficient facilities are available for the disposal of the excavated materials under Alternative 4. Alternative 4 would be administratively feasible, although it would require significant administrative coordination efforts. Excavation work would need to be completed and maintained in a highly urban area that includes extensive underground utility infrastructure, including gas and electric lines, water mains, cable and telephone lines. The excavation work would impose additional engineering and structural requirements that are disruptive to the public and may result in longer construction periods. Utilities may need to be removed and temporarily relocated. In addition, excavation work may require structural supports such as the underpinning of adjacent buildings to temporarily support foundations during excavation and shoring for worker safety.
Present Value Cost	$0	$36.2M	$34.2M	$39.4M

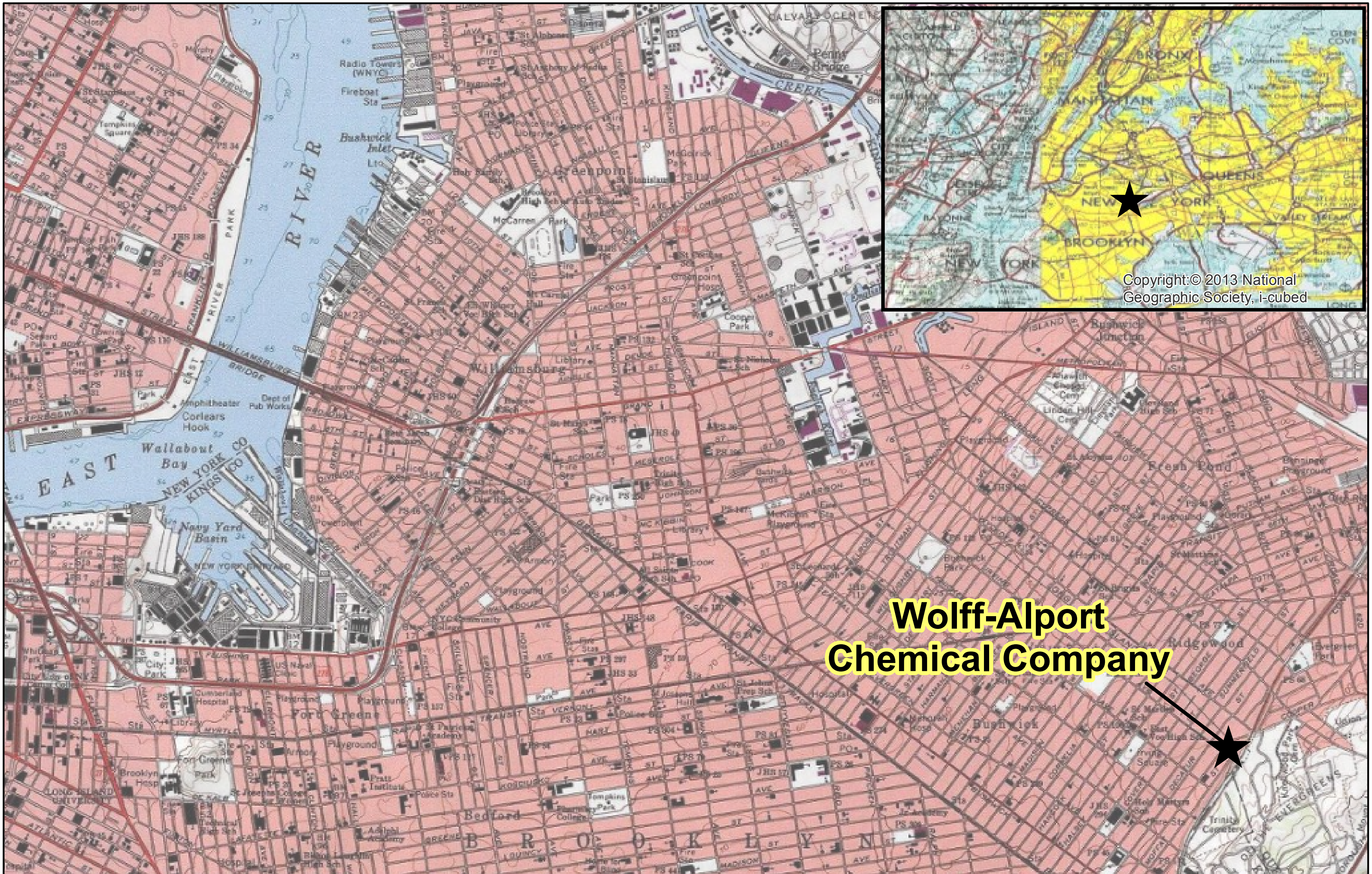
Notes:

1. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix D.
2. Costs presented are expected to have an accuracy between -30 to +50 percent of actual costs based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for feasibility study evaluation level purposes
3. Present value calculation is based on a 7 percent discount rate.

Table 4-2
Sensitivity Analysis of Capital Costs
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Scenario	Description	Baseline Cost	Cost based on Change	Difference from Baseline	Percent Difference from Baseline
Scenario 1	Radiological Waste Volumes Decreased by 20% with total waste volume held constant	$39,402,000	$35,805,000	-$3,597,000	-9%
Scenario 2	Total volume of waste is classified as radiological waste and increase in volume of TSCA/radiological combined waste to 500 tons	$39,402,000	$40,401,000	$999,000	3%
Senario 3	Production Rates Decreased by 20%	$39,402,000	$42,129,000	$2,727,000	7%

Figures



N
W E
S

0 0.25 0.5 1 Miles

Figure 1-1
Site Location Map
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

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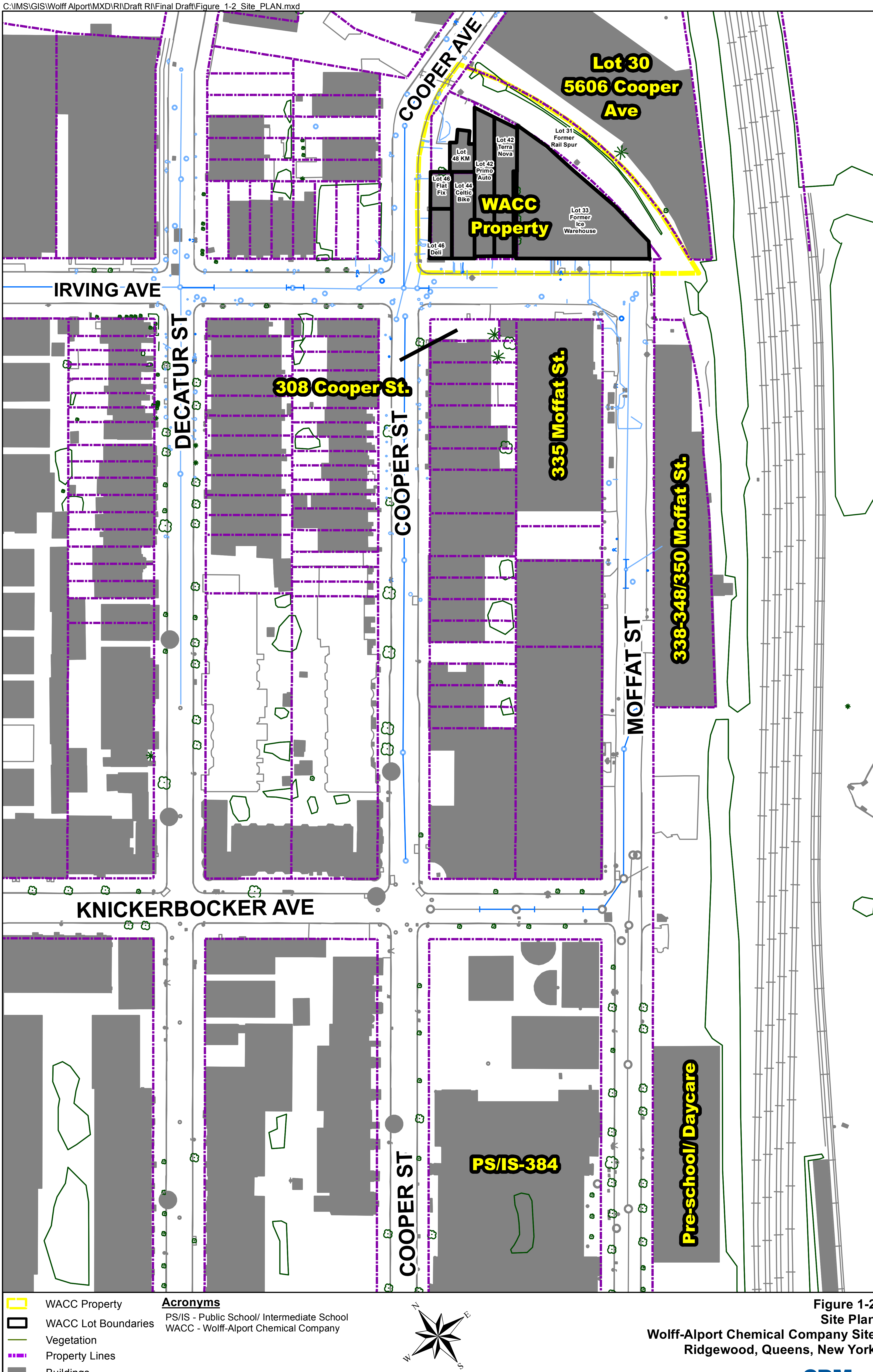


Figure 1-2
Site Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

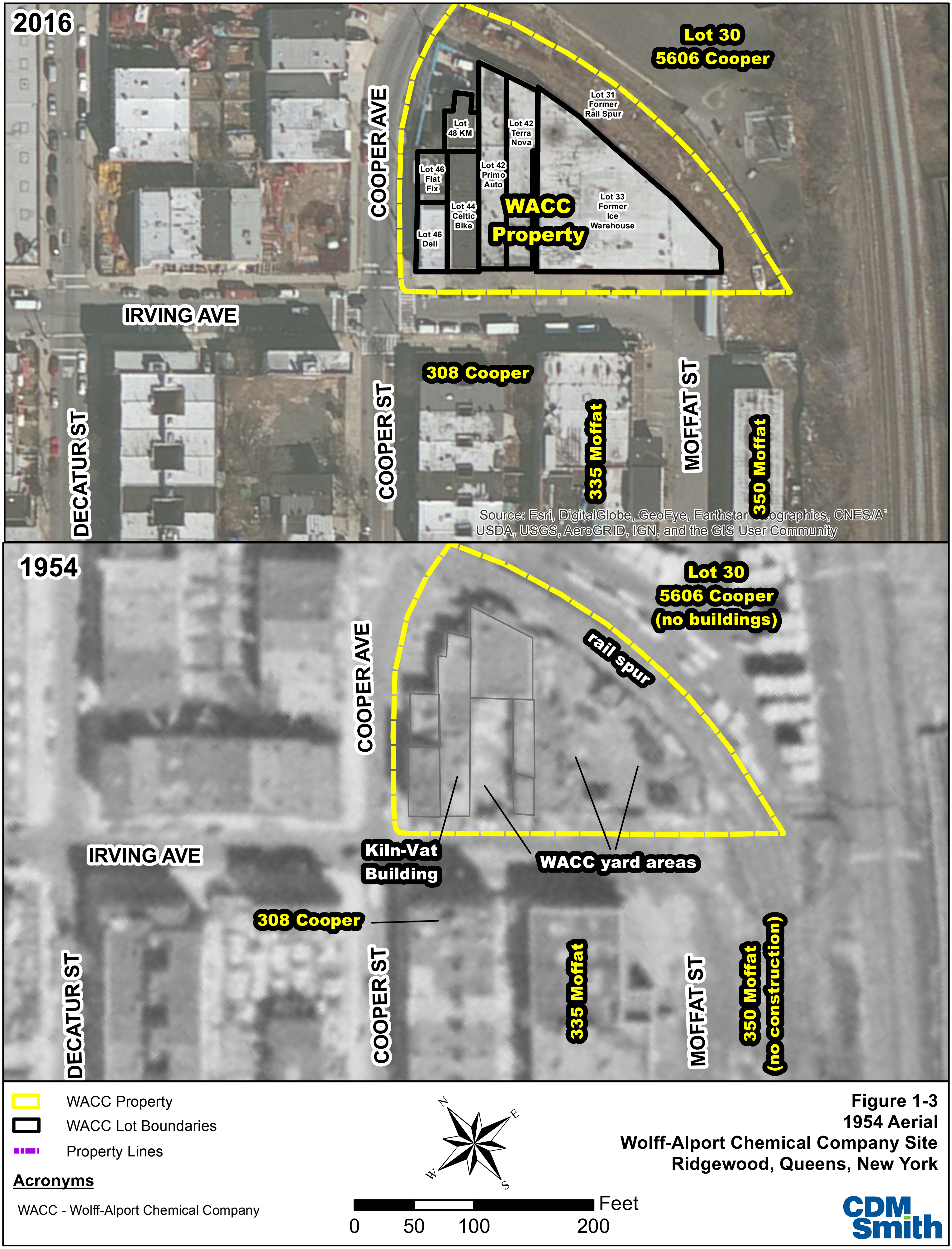
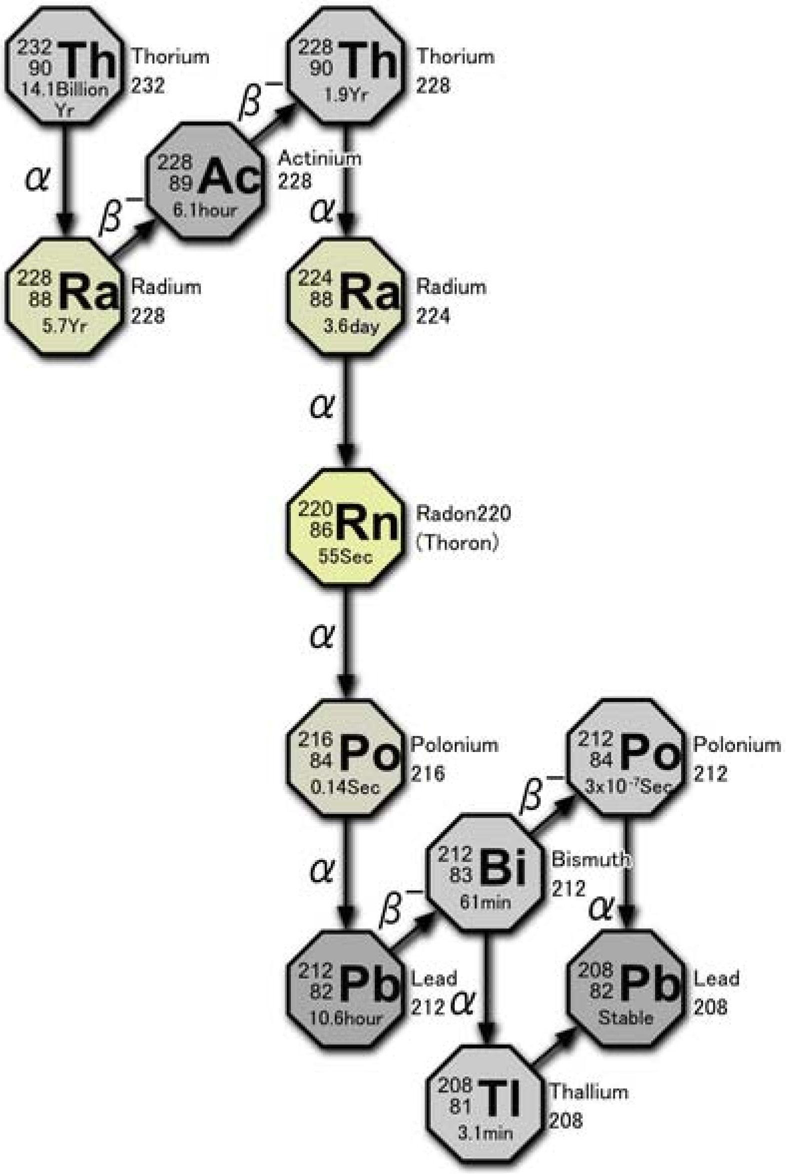


Figure 1-3
1954 Aerial
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Thorium-232 Decay Chain



Uranium-238 Decay Chain

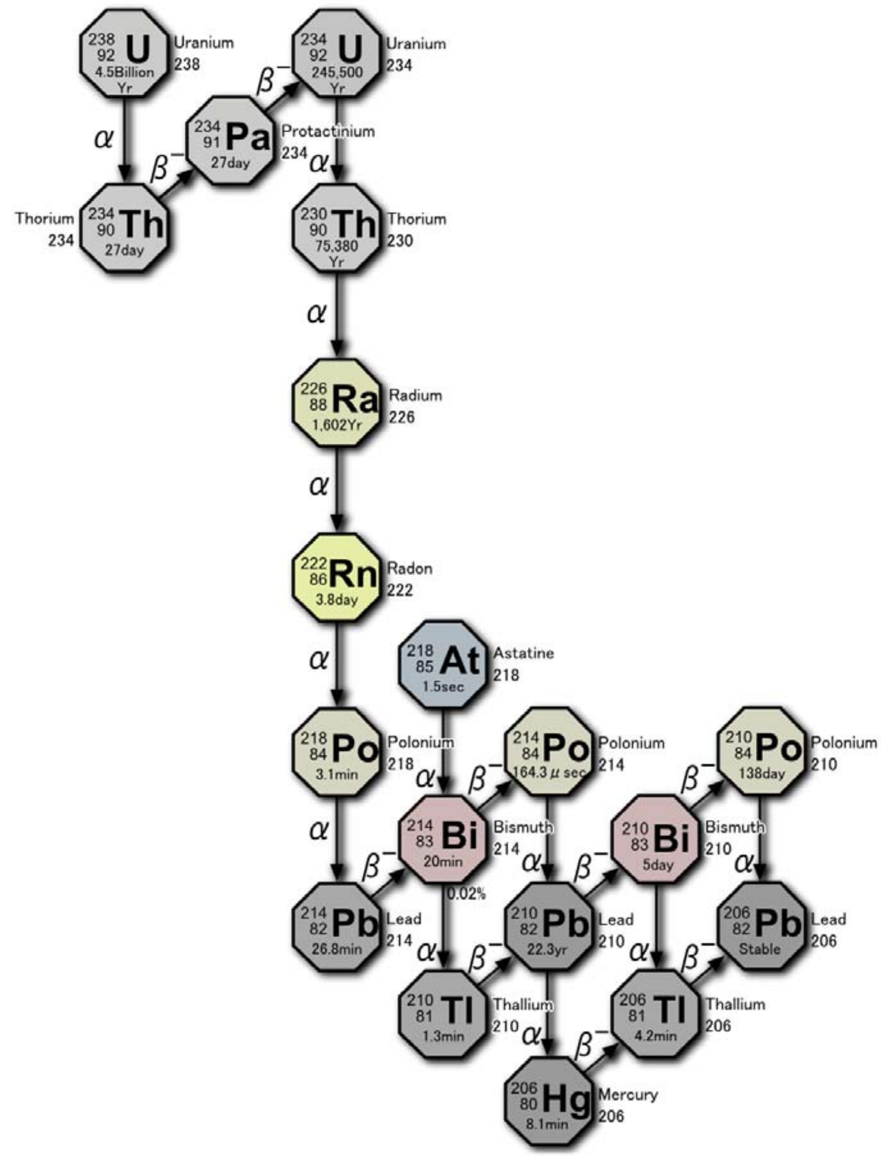
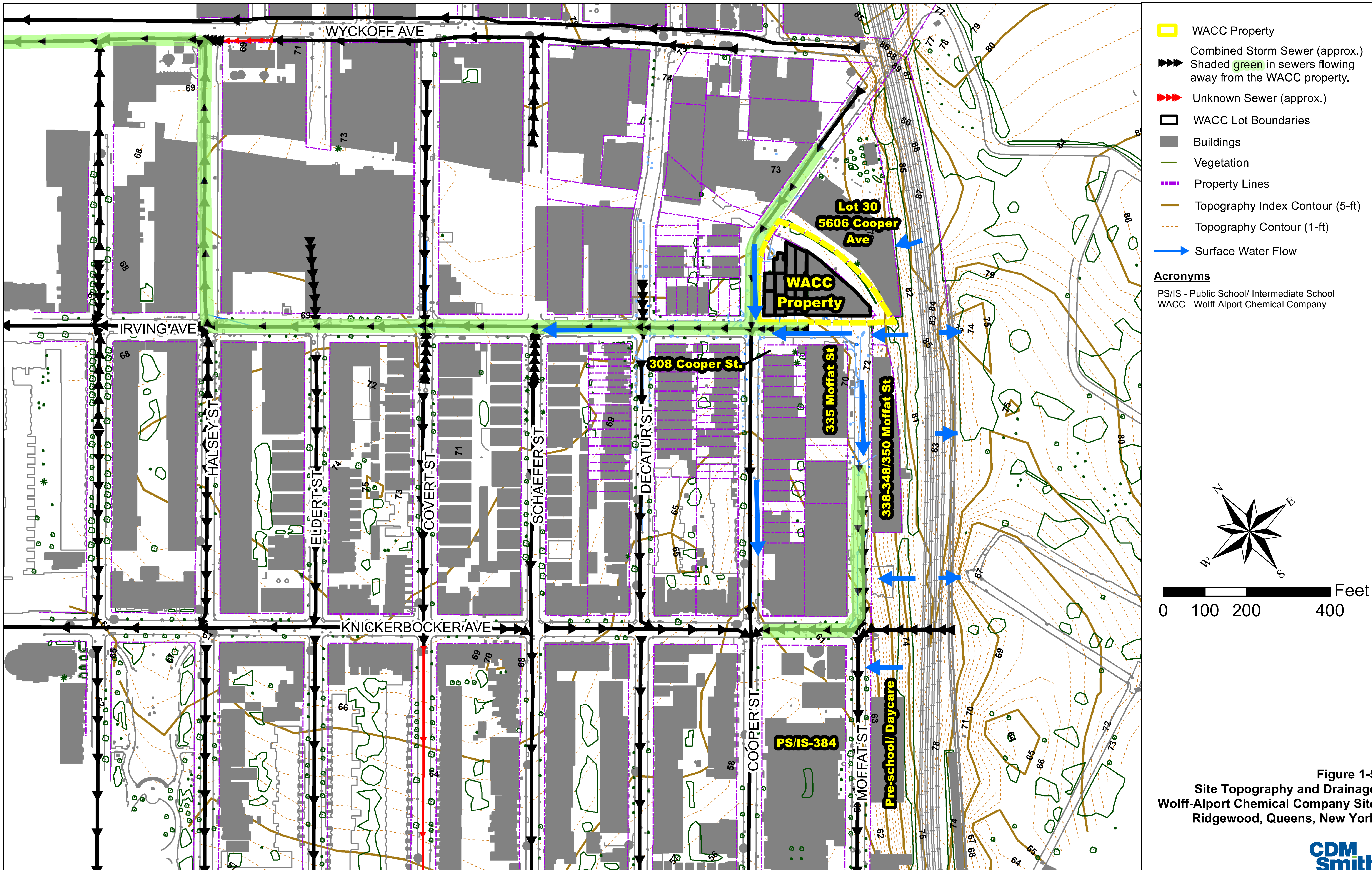


Figure 1-4
Decay Chains for Thorium-232 and Uranium-238
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



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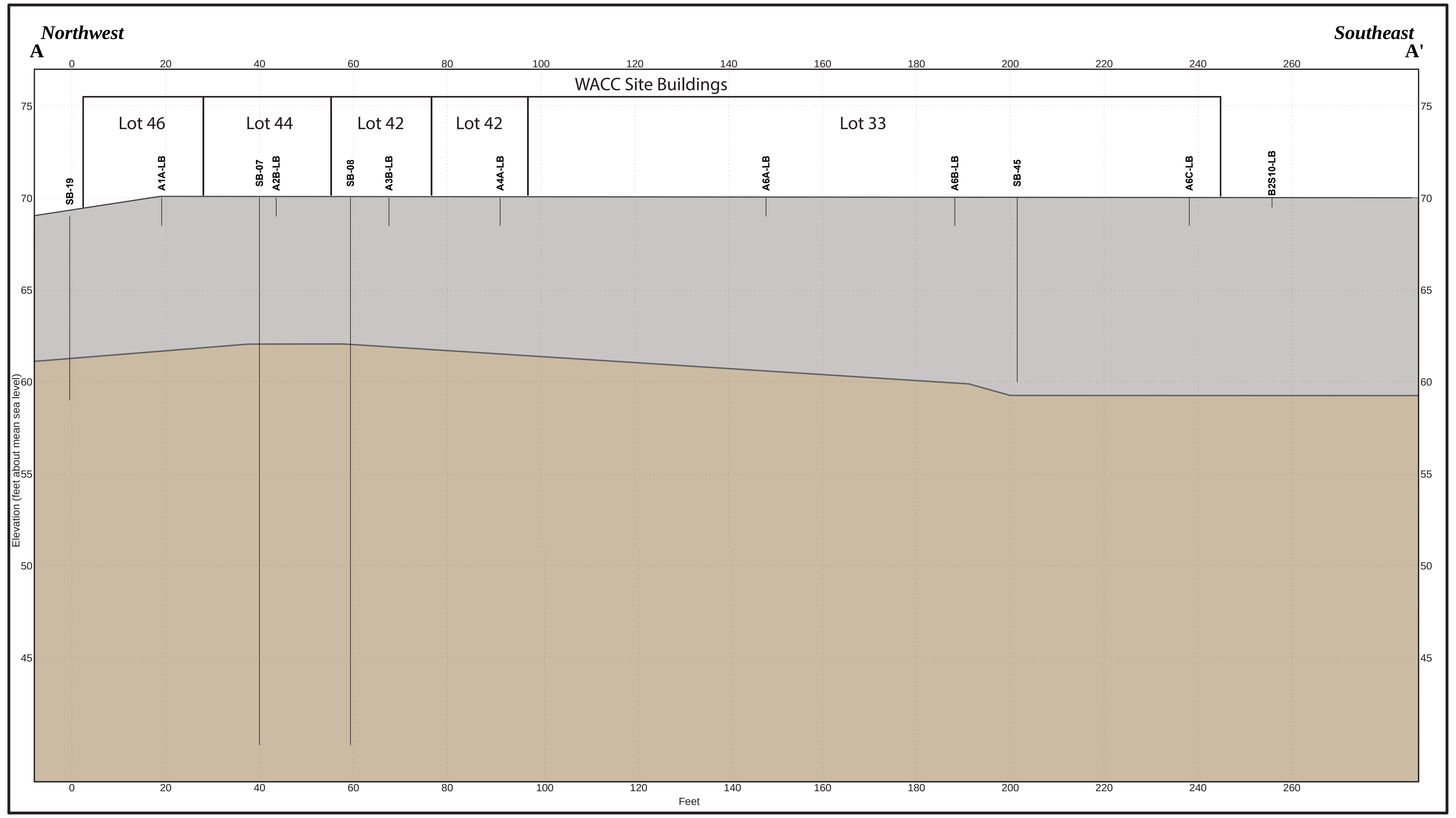

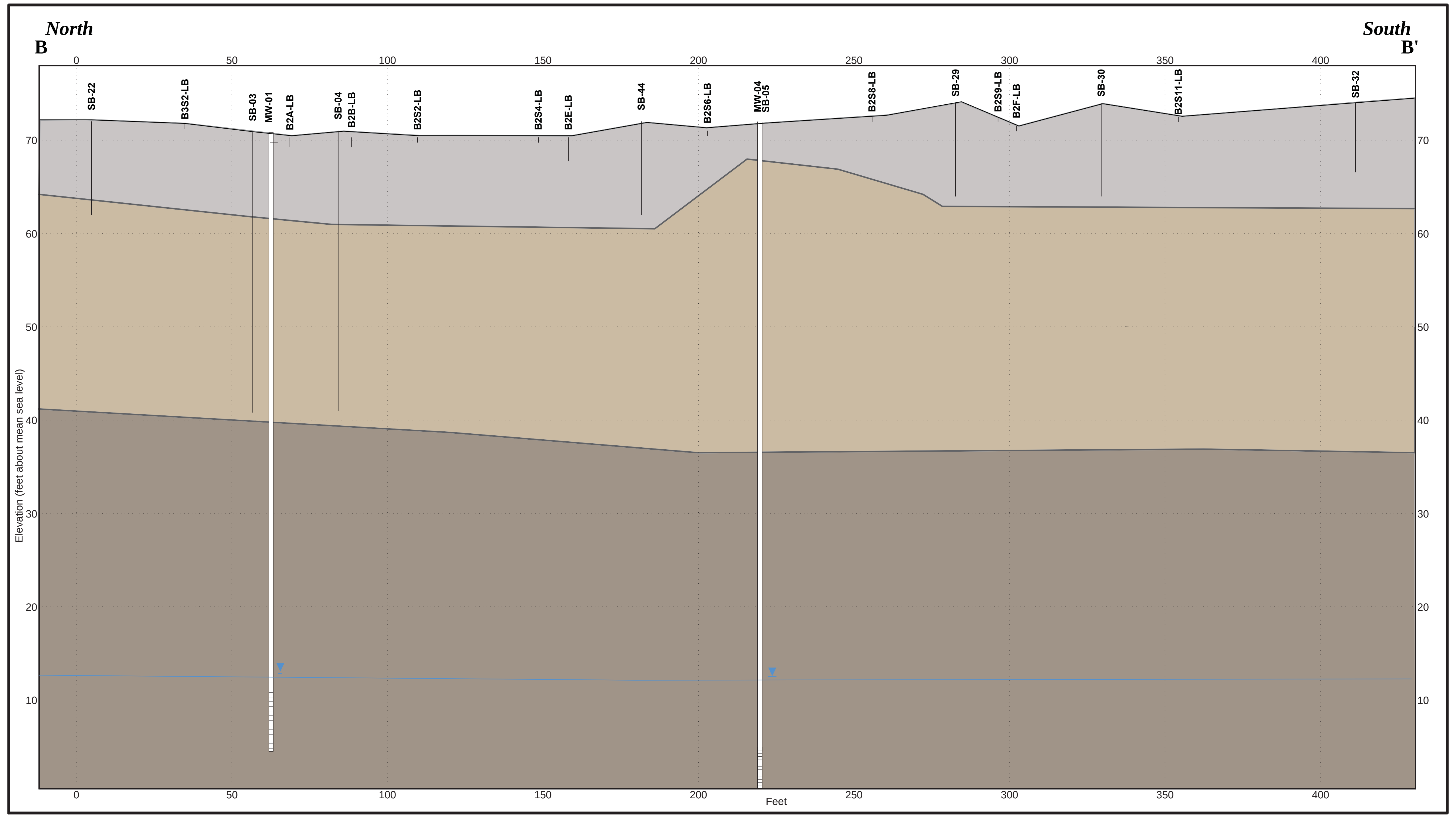

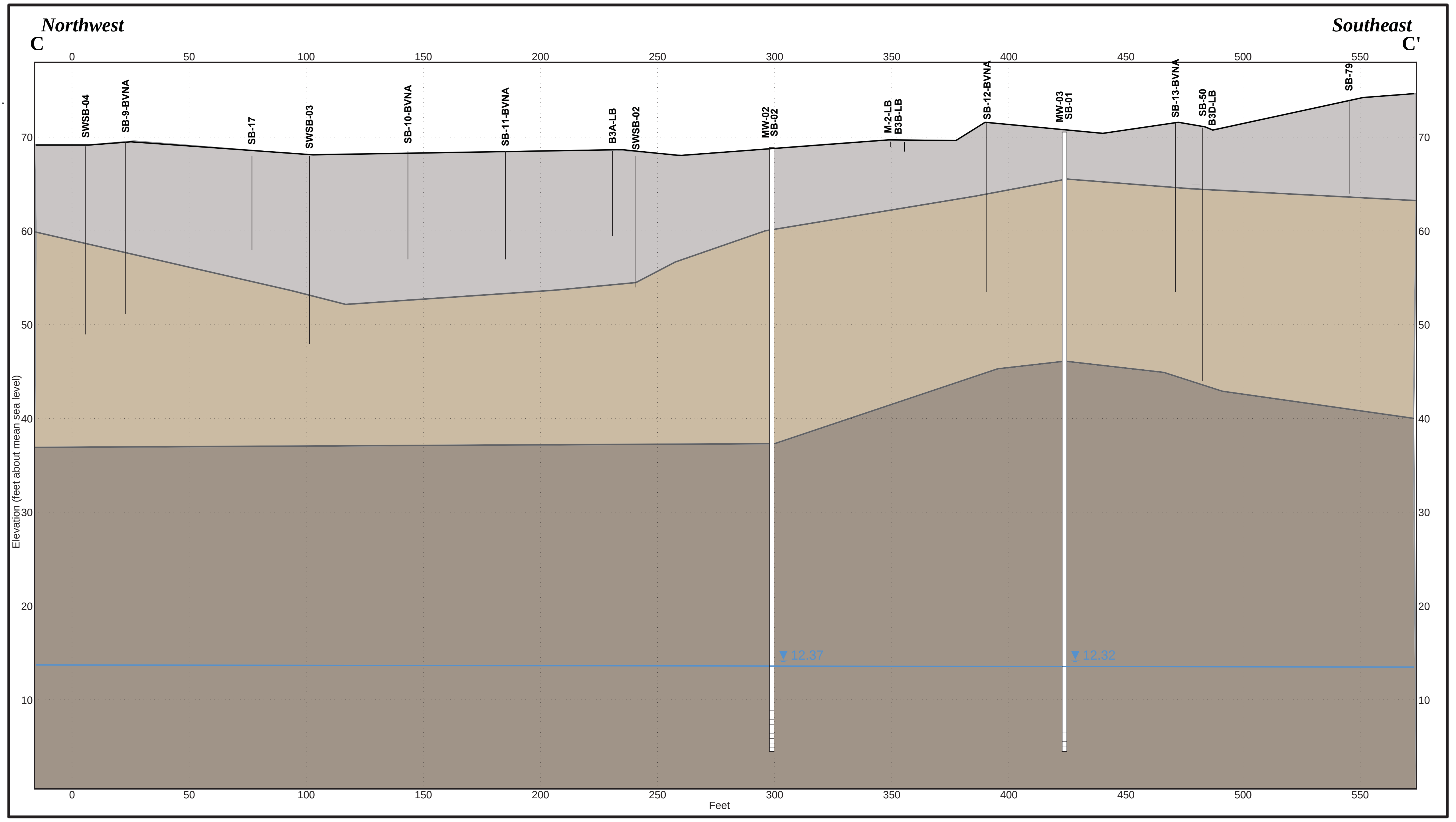

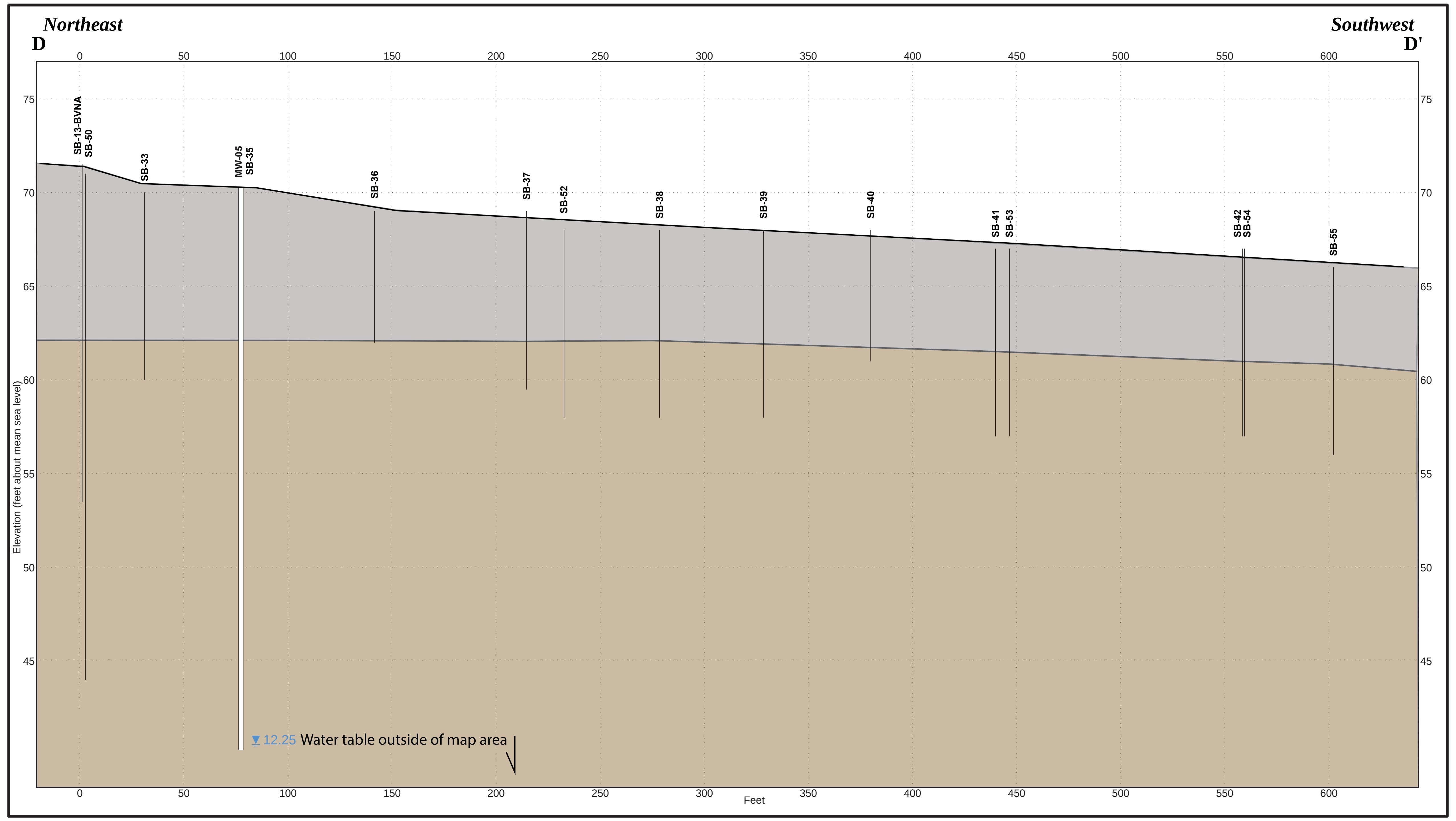

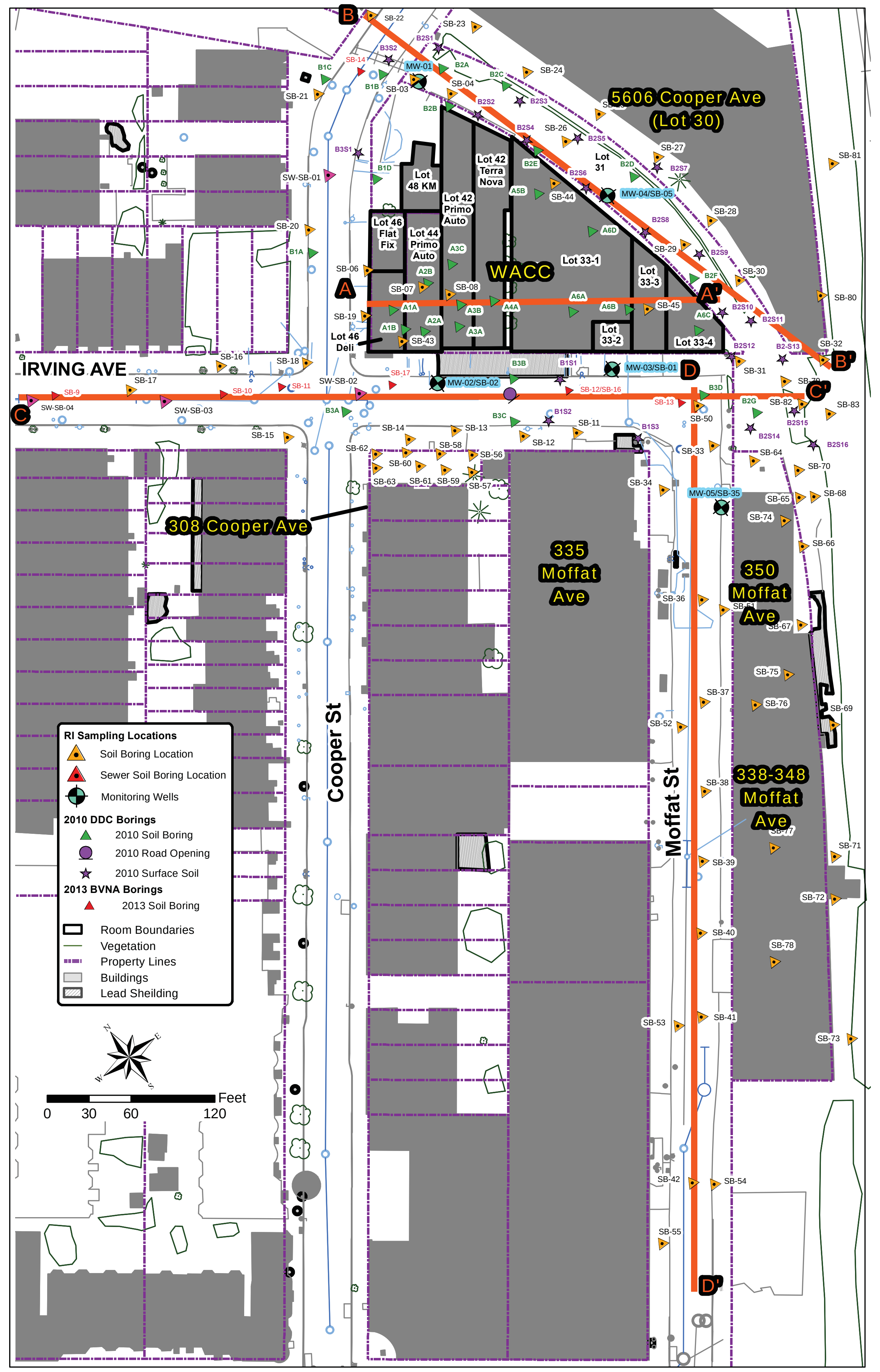

Cross Section Locations

Lithologic Legend:

General fill - brick material, stone, cinder, often with surficial layers of grey ashy tailings (1-3 ft thick)

Upper Glacial Aquifer Deposits

Till - dense silty sands and gravel

Outwash - coarser sands and gravels

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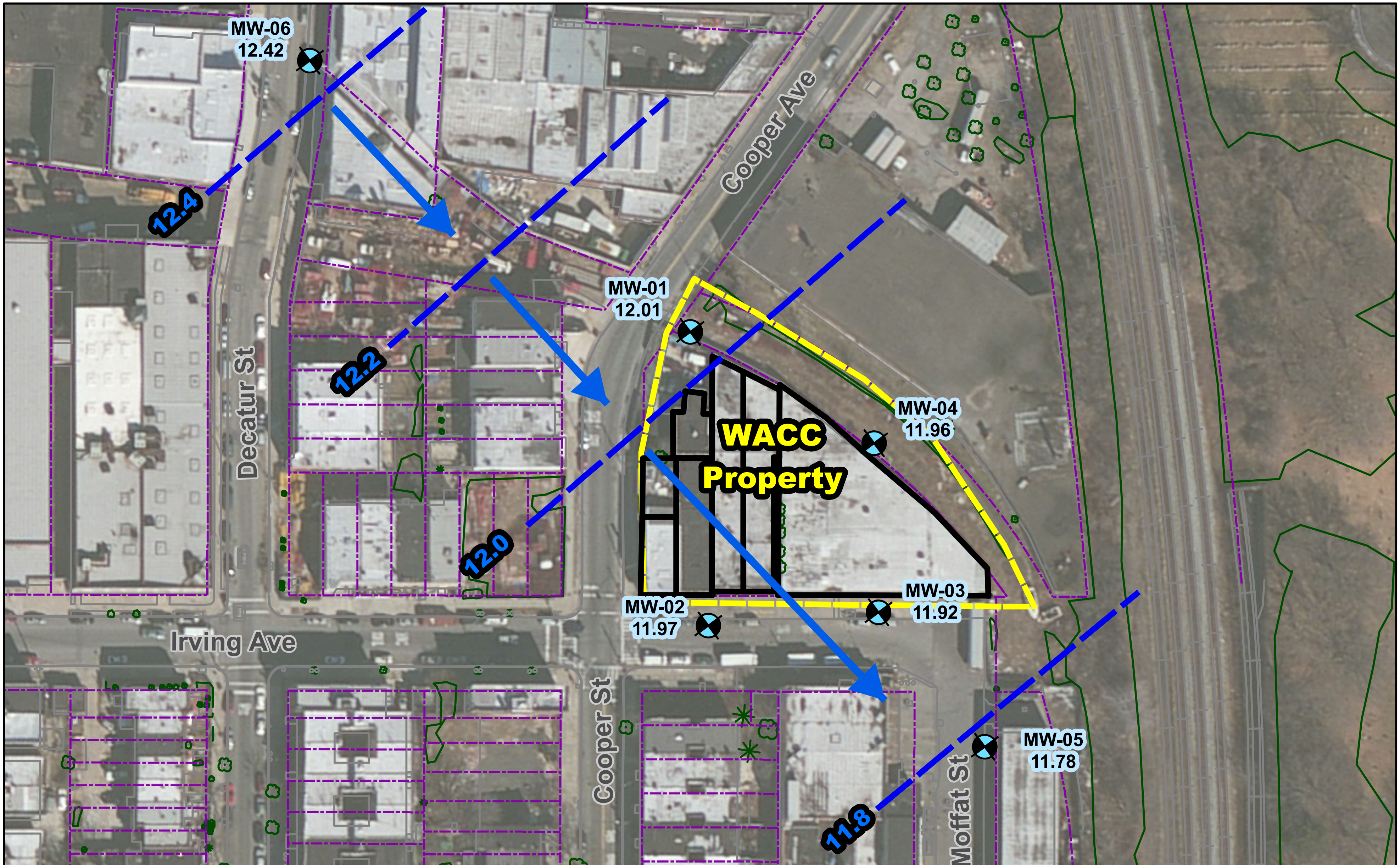
Figure 1-6
Geologic Cross Sections
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY



RI Sampling Locations
Monitoring Wells
WACC Property
WACC Lot Boundaries
Vegetation
Property Lines

12.2 Potentiometric Contour (elevation in feet amsl)

Groundwater Flow Direction

Notes
Groundwater elevations collected on 4/12/2017.
Groundwater elevations presented in feet above mean sea level.

Acronyms
amsl - above mean sea level
WACC - Wolff-Alport Chemical Company

N E S W

Feet
0 50 100 200

Figure 1-7
April 2017
Potentiometric Surface Map
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

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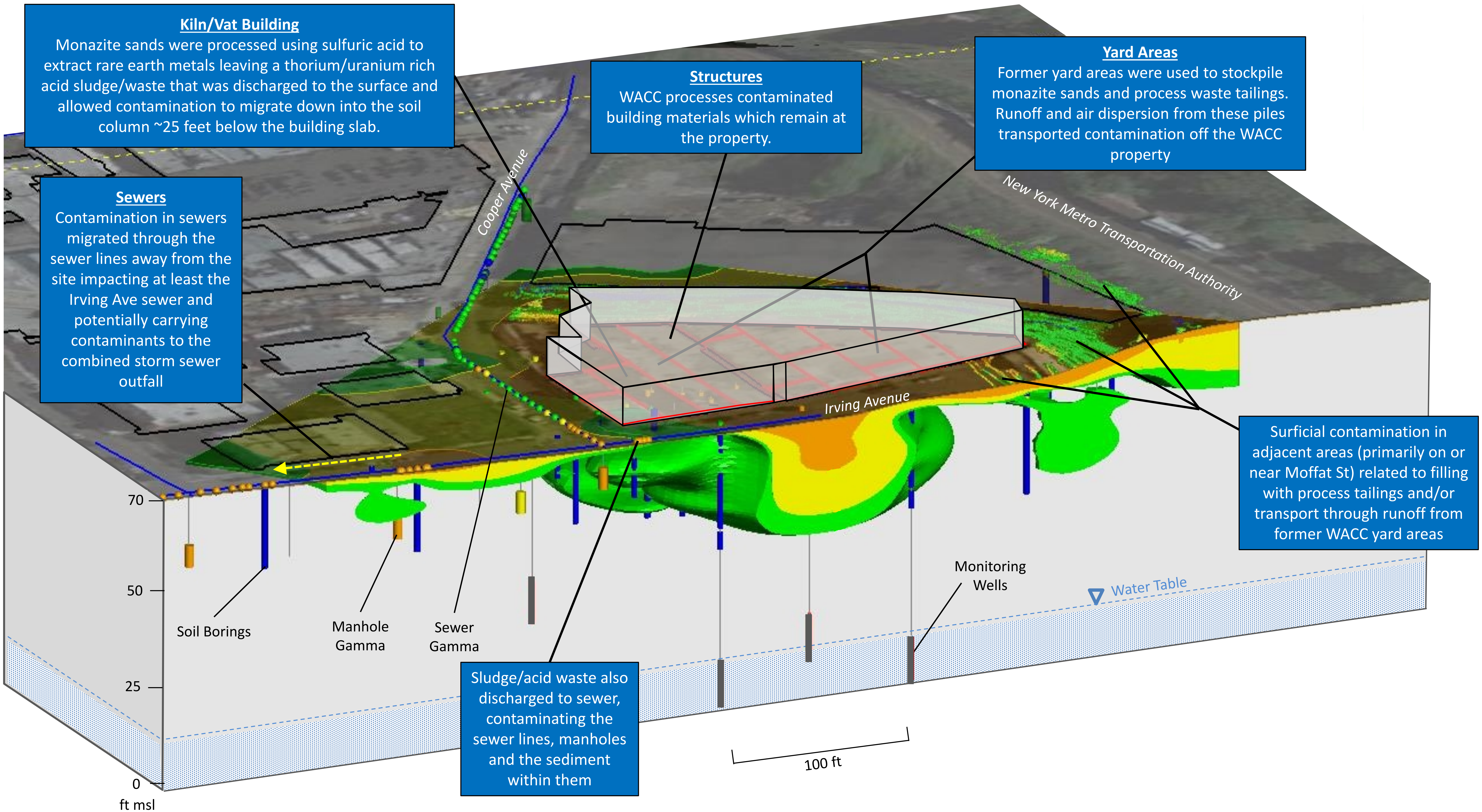


Notes

CPM – represents range of gamma activity in counts per minute

WACC – Wolff-Alport Chemical Company

Radiological contamination in the Conceptual Site Model is represented as colors grading from green (less-contaminated) to orange (more-contaminated),

CDM Smith

Figure 1-8

Conceptual Site Model

Wolff-Alport Chemical Company Site

Ridgewood, Queens, New York

CONTAMINANTS OF CONCERN	PRELIMINARY REMEDIATION GOAL
AROCLOR 1260	1 mg/kg
BENZO(A)PYRENE	1 mg/kg
THORIUM-232	5.22 pCi/g
RADIUM-226	1.92 pCi/g

LEGENDS

- 2015 RI BORINGS
- 2013 BVNA BORINGS
- 2010 BERGER BORINGS
- RI MONITORING WELLS
- RESULT EXCEEDS PRELIMINARY REMEDIATION GOALS
- NOT ANALYZED
- RESULT BELOW PRELIMINARY REMEDIATION GOALS
- EXTENT OF CONTAMINATION

NOTES:

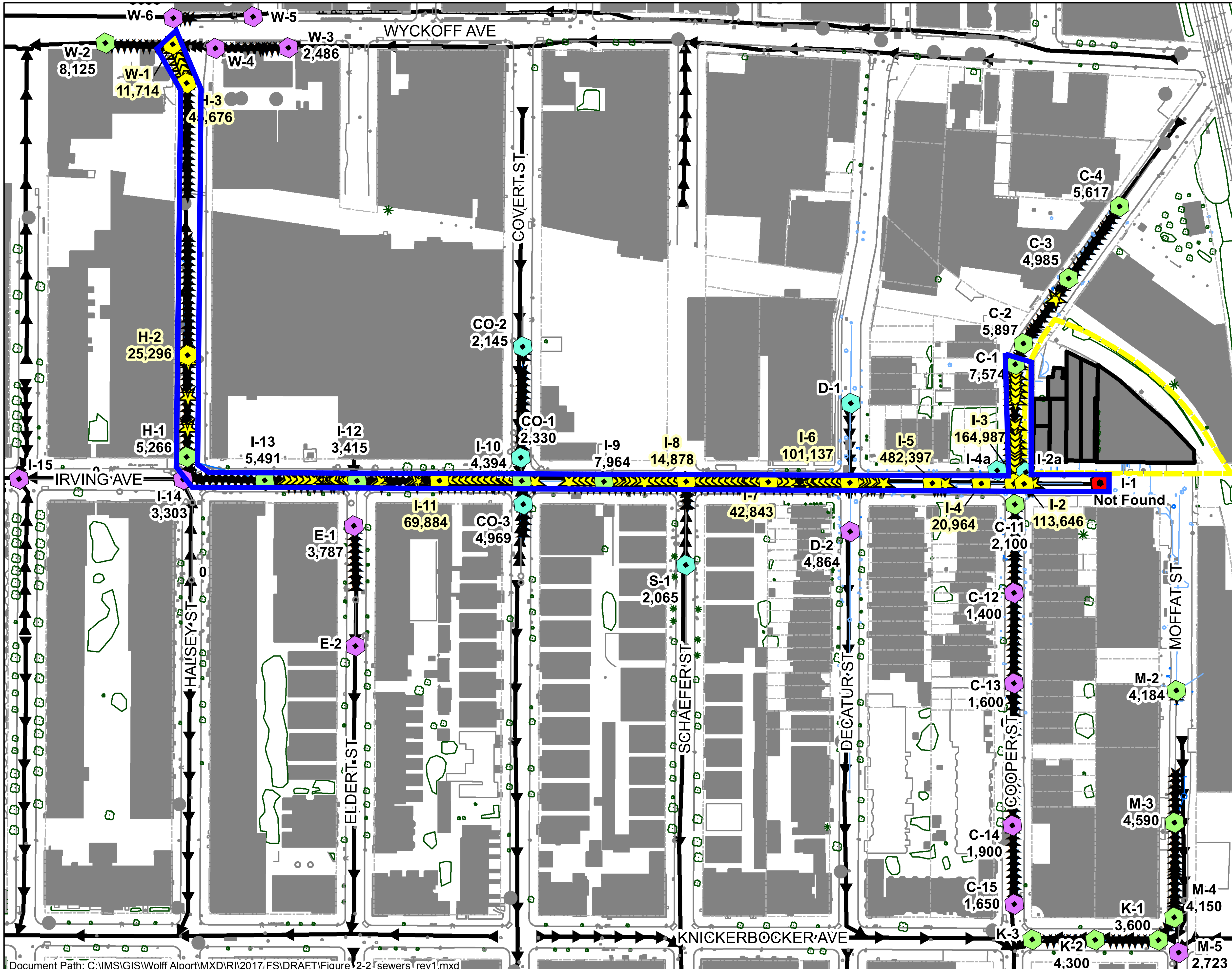
1. BORING SYMBOLS SHOWN IN RED INDICATES RESULT EXCEEDS PRELIMINARY REMEDIATION GOALS AT THAT LOCATION.
2. AN EXCEEDANCE MARKED IN THE "RAD" COLUMN INDICATES AN EXCEEDANCE OF THE THORIUM-232 CRITERIA AND/OR THE RADIUM-226 CRITERIA.
3. HOTSPOTS ARE DEFINED AS THOSE AREAS CONTAINING SAMPLES WITH COMBINED TH-232 AND RA-226 CONCENTRATIONS GREATER THAN 50 pCi/g.

ACRONYMS:

RAD – THORIUM-232 AND RADIUM-226
PCBs – POLYCHLORINATED BIPHENYLS
BAP – BENZO(A)PYRENE
mg/kg – MILLIGRAMS PER KILOGRAM
pCi/g – PICOCURIES PER GRAM

CDM Smith

Figure 2-1
Extent of Contamination in Soils
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York



Sewer Survey Locations

- Primary Manholes (fiberscope)
- Secondary Upstream Locs
- Background Manholes
- Manhole Inaccessible
- I-2 / 113,646 — Manhole Identifier / Manhole Gamma (cpm)

Manhole highlighted if gamma counts greater than 10,000 cpm.

In-Sewer Gamma Scan (CPM)

- <10,000
- >10,000 (impacted sewers)
- WACC Property
- WACC Lot Boundaries
- Vegetation
- Property Lines
- Buildings
- Extent of high gamma readings in sewers

Notes

1. Manhole gamma counts measured at the most elevated area within the vault.
2. In-sewer gamma scans are approximate locations.

Acronyms

CPM - counts per minute
RI - Remedial Investigation
WACC - Wolff-Alport Chemical Company

N E S W

Feet
0 75 150 300

Figure 2-2
Extent of Elevated Gamma Counts in Sewers
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

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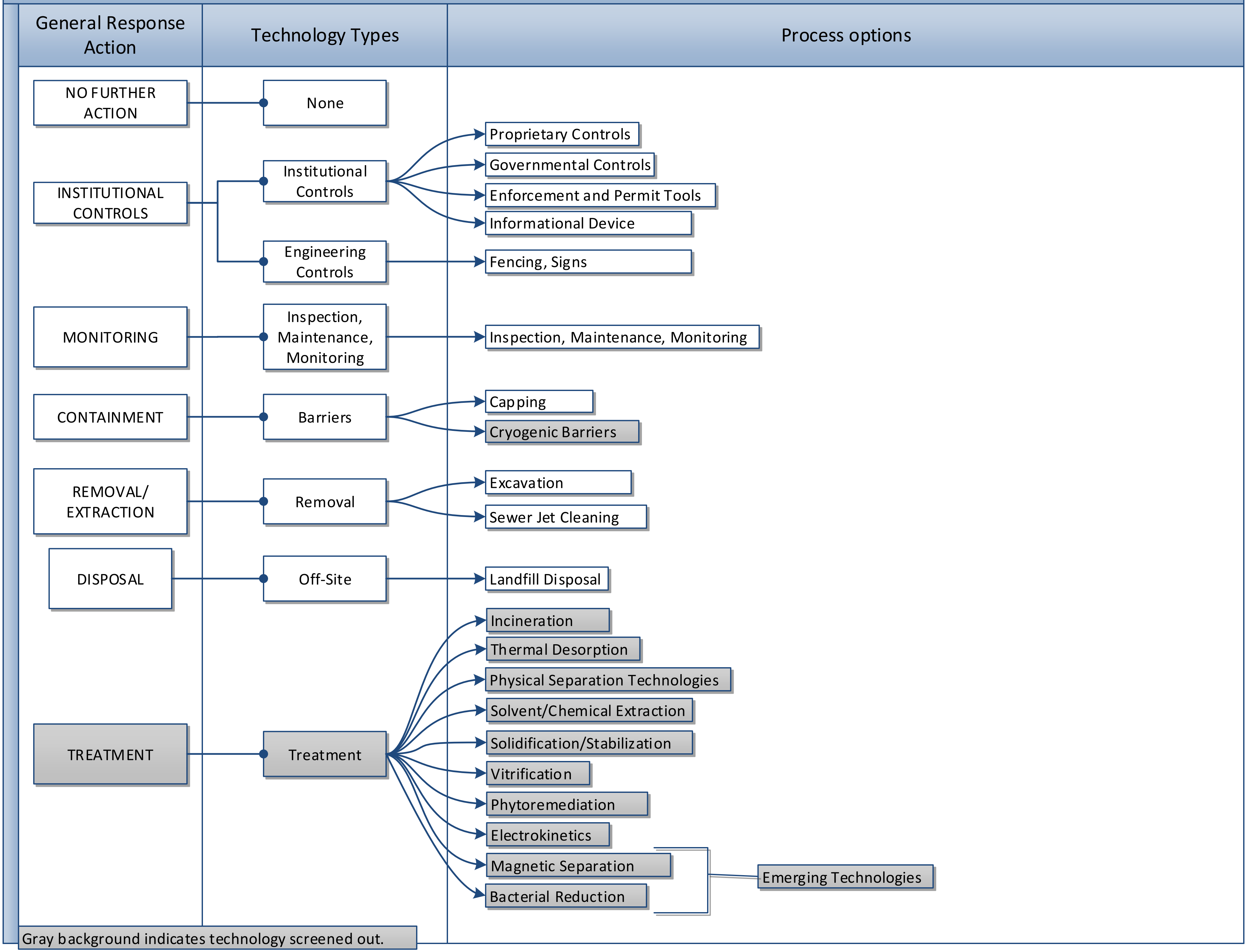
Figure 2-3 Technology Screening Process



MANHOLE ID	DEPTH (FEET BELOW GROUND SURFACE)
C-1	9.7
I-2	10
I-3	10
I-4	13.8
I-5	13.1
I-6	14.5
I-7	15.5
I-8	17.5
I-9	16.5
I-10	16.3
I-11	16
I-12	16
I-13	17
H-1	16.7
H-2	18.3
H-3	18
W-1	18

LEGENDS

- 2015 RI BORINGS
- 2013 BVNA BORINGS
- 2010 BERGER BORINGS
- EXTENT OF SEWER REQUIRING REMOVAL
- EXTENT OF SEWER REQUIRING SEWER JET CLEANING AND INVESTIGATION

NOTES:

1. EXTENT OF SEWER CONTAMINATION IS DELINEATED USING GAMMA MEASUREMENTS WITH A CRITERIA OF 10,000 COUNTS PER MINUTE.
2. IT IS ASSUMED THAT SOILS ABOVE THE SEWER PIPELINE ARE NOT CONTAMINATED EXCEPT FOR THOSE SOILS FROM 0-2 FEET AT SWSB-03.
3. IT IS ASSUMED THAT SOILS AROUND SEWER PIPELINE AND 6 INCHES BELOW PIPELINE ARE CONTAMINATED.
4. I-1 WAS UNABLE TO BE LOCATED DURING THE 2015 REMEDIAL INVESTIGATION. HOWEVER, AN INVESTIGATION CONDUCTED IN 2009 (LOUIS BERGER & ASSOCIATES 2010) FOUND THE MANHOLE UNDER A 6-FOOT BY 6-FOOT SECTION OF ASPHALT WHICH WAS OPENED TO COMPLETE THE INVESTIGATION.
5. THE SEWER PIPE FROM MANHOLE C-1 TO MANHOLE I-3 AND FROM MANHOLE I-4 TO W-1 WOULD BE REMEDIATED THROUGH THE FOLLOWING STEPS:
   A. DECONTAMINATE THE SEWER PIPE USING JET WASHING.
   B. PERFORM A GAMMA SURVEY.
   C. FOR AREAS WITH GAMMA MEASUREMENTS EXCEEDING 10,000 COUNTS PER MINUTE, ADDITIONAL INVESTIGATION WOULD BE PERFORMED TO DETERMINE THE EXTENT AND LEVEL OF CONTAMINATION.
   D. THE SEWER PIPE AND BEDDING MATERIALS EXCEEDING THE PRGS WOULD BE EXCAVATED AND DISPOSED OFF SITE.
6. DUE TO HIGH CONTAMINANT CONCENTRATIONS, THE SEWER PIPE AND BEDDING MATERIALS EXCEEDING THE PRGS WITHIN THIS AREA WOULD BE EXCAVATED AND DISPOSED OFF SITE.

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Figure 3-1
Sewer Remediation Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

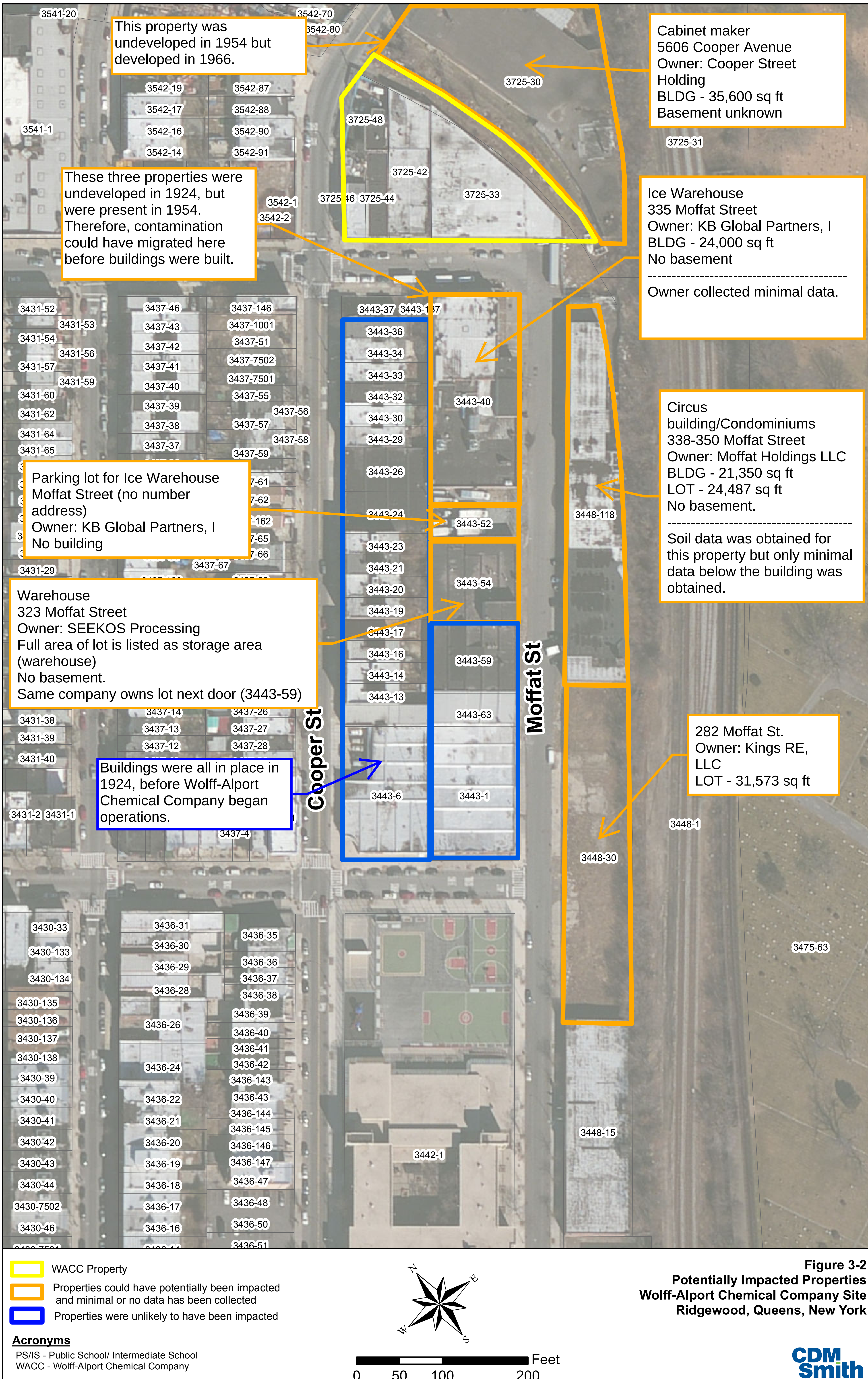
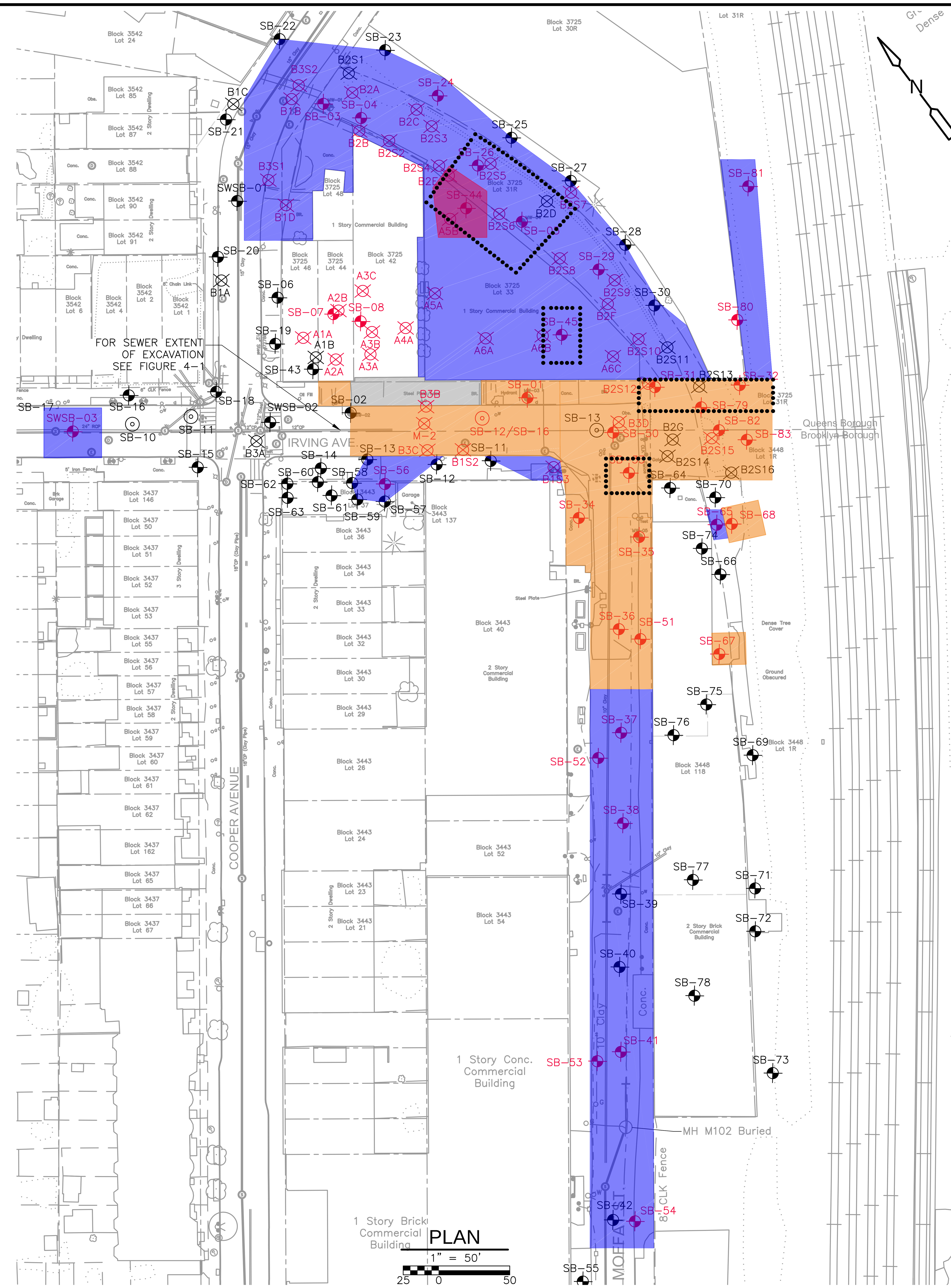


Figure 3-2
Potentially Impacted Properties
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York



LEGENDS

- 2015 RI BORINGS
- 2013 BVNA BORINGS
- 2010 BERGER BORINGS
- RI MONITORING WELLS
- 2 FT DEPTH OF EXCAVATION
- 3 FT DEPTH OF EXCAVATION
- 4 FT DEPTH OF EXCAVATION
- EXTENT OF PCB AND/OR PAH CONTAMINATION

NOTES:

1. BORING SYMBOLS SHOWN IN RED INDICATES RESULT EXCEEDS PRELIMINARY REMEDIATION GOALS AT THAT LOCATION.
2. THE HORIZONTAL EXTENT OF EXCAVATION IS DELINEATED USING THE NEAREST CLEAN SAMPLE IN THE OUTWARD DIRECTION FROM THE WOLFF-ALPORT CHEMICAL COMPANY PROPERTY. IF SUCH A SAMPLE DOES NOT EXIST, THE EXTENT IS ESTIMATED AS 20 FEET AWAY FROM THE FURTHEST SAMPLE RESULT ABOVE PRELIMINARY REMEDIATION GOALS OR TO THE NEXT PHYSICAL BARRIER (E.G., BUILDING).

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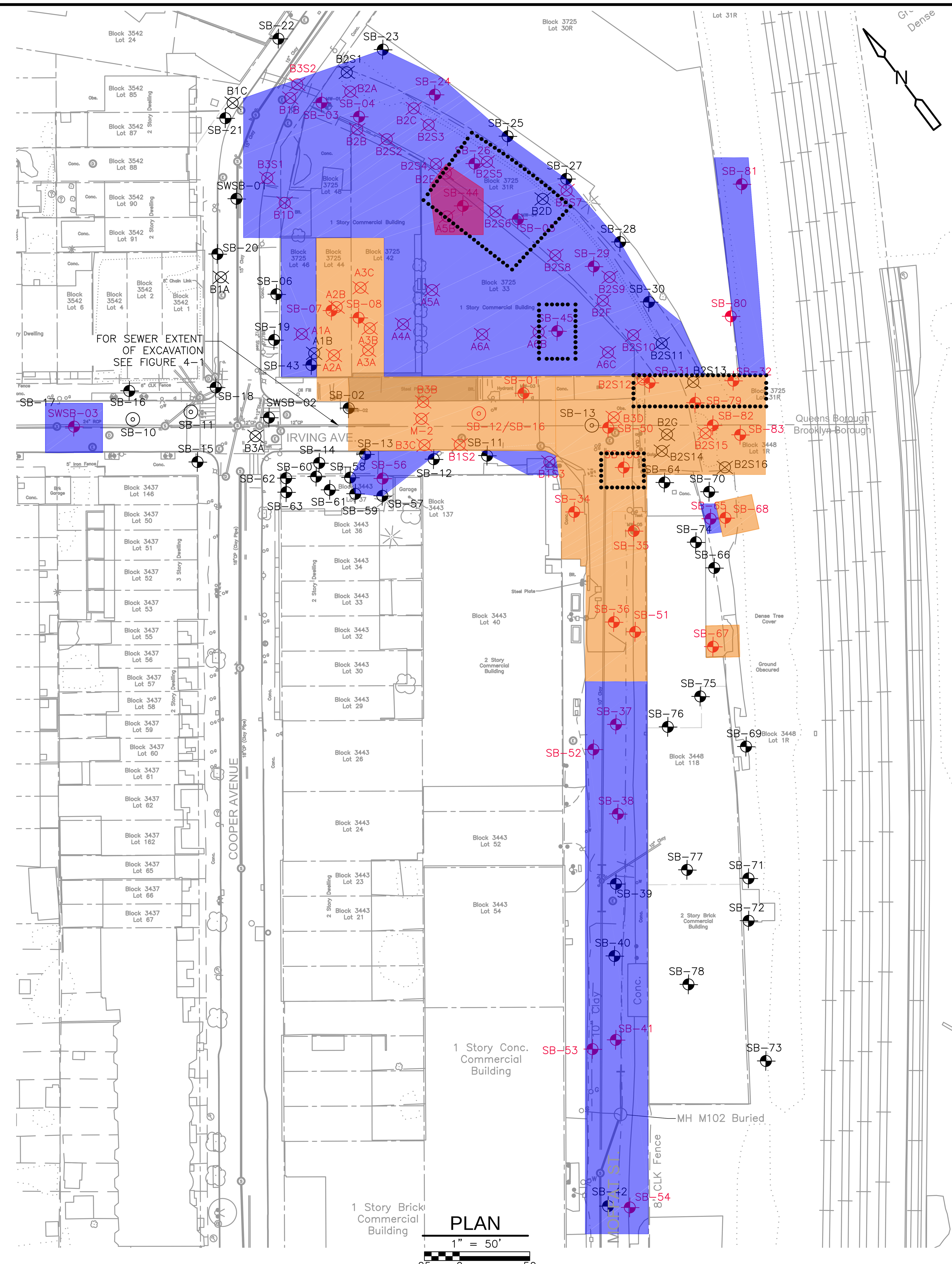
Figure 3-3
Alternative 2 Excavation Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York



LEGENDS

- 2015 RI BORINGS
- 2013 BVNA BORINGS
- 2010 BERGER BORINGS
- RI MONITORING WELLS
- 2 FT DEPTH OF EXCAVATION
- 3 FT DEPTH OF EXCAVATION
- 4 FT DEPTH OF EXCAVATION
- EXTENT OF PCB AND/OR PAH CONTAMINATION

NOTES:

1. BORING SYMBOLS SHOWN IN RED INDICATES RESULT EXCEEDS PRELIMINARY REMEDIATION GOALS AT THAT LOCATION.
2. THE HORIZONTAL EXTENT OF EXCAVATION IS DELINEATED USING THE NEAREST CLEAN SAMPLE IN THE OUTWARD DIRECTION FROM THE WOLFF-ALPORT CHEMICAL COMPANY PROPERTY. IF SUCH A SAMPLE DOES NOT EXIST, THE EXTENT IS ESTIMATED AS 20 FEET AWAY FROM THE FURTHEST SAMPLE RESULT ABOVE PRELIMINARY REMEDIATION GOALS OR TO THE NEXT PHYSICAL BARRIER (E.G., BUILDING).

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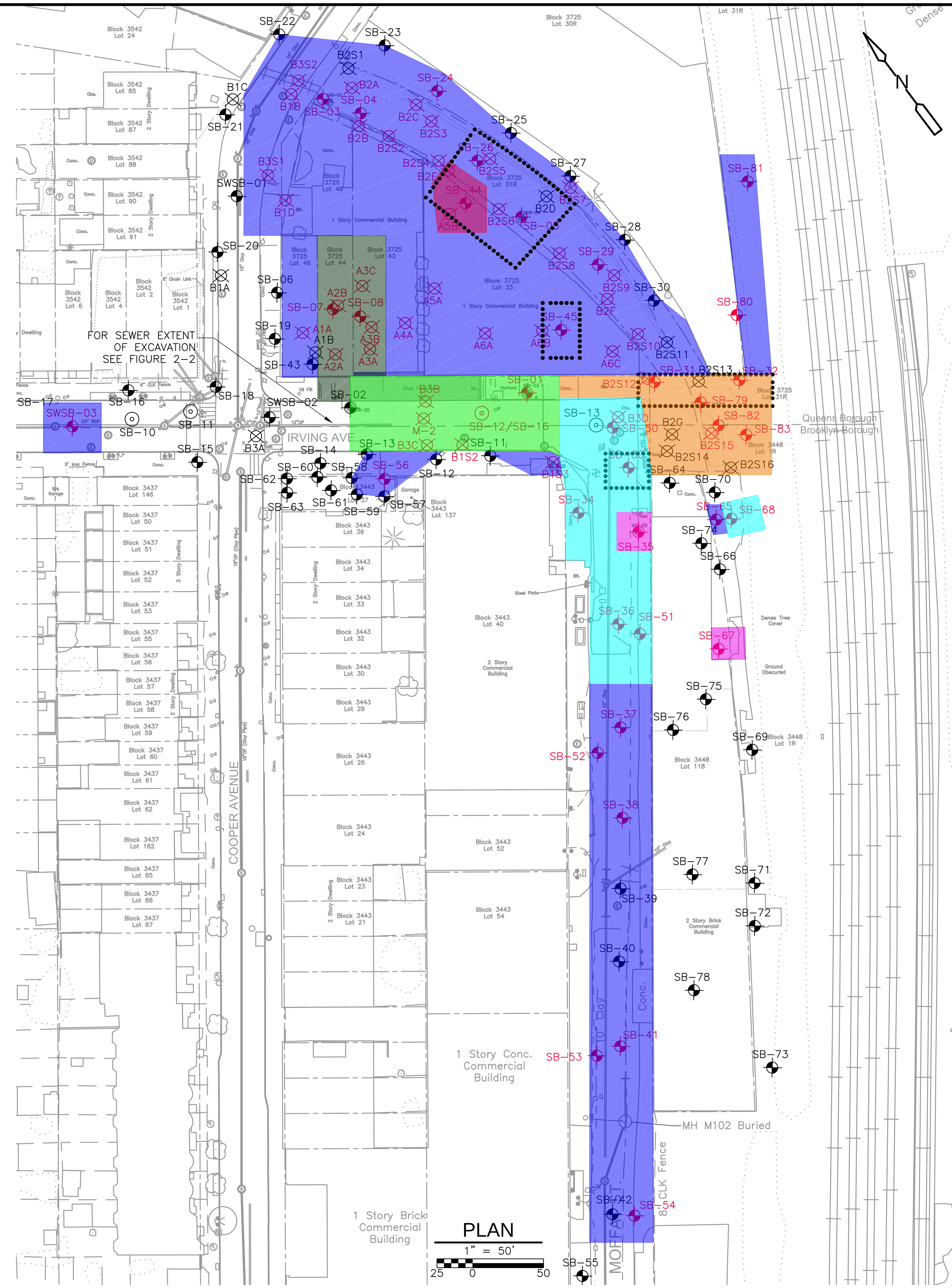
Figure 3-4
Alternative 3 Excavation Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York



LEGENDS

- 2015 RI BORINGS
- 2013 BVNA BORINGS
- 2010 BERGER BORINGS
- RI MONITORING WELLS
- EXTENT OF PCB AND/OR PAH CONTAMINATION

- 2 FT DEPTH OF EXCAVATION
- 3 FT DEPTH OF EXCAVATION
- 4 FT DEPTH OF EXCAVATION
- 6 FT DEPTH OF EXCAVATION
- 8 FT DEPTH OF EXCAVATION
- 20 FT DEPTH OF EXCAVATION
- 30 FT DEPTH OF EXCAVATION

NOTES:

1. BORING SYMBOLS SHOWN IN RED INDICATES RESULT EXCEEDS PRELIMINARY REMEDIATION GOALS AT THAT LOCATION.
2. EXTENT OF EXCAVATION IS DELINEATED USING THE NEAREST CLEAN SAMPLE IN THE OUTWARD DIRECTION FROM THE WOLFF-ALPORT CHEMICAL COMPANY PROPERTY. IF SUCH A SAMPLE DOES NOT EXIST, THE EXTENT IS ESTIMATED AS 20 FEET AWAY FROM THE FURTHEST SAMPLE RESULT ABOVE PRELIMINARY REMEDIATION GOALS OR TO THE NEXT PHYSICAL BARRIER (E.G., BUILDING).

CDM Smith

Figure 3-5
Alternative 4 Excavation Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

Appendices

Appendix A

Table 4-1a
RI Soil Screening Criteria - VOCs
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY

Volatile Organic Compounds (All units: µg/kg)	CAS Number	Standards					RI Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
1,1,1-Trichloroethane	71-55-6	8,100,000	100,000	500,000	1,000,000	NL	**100,000**
1,1,2,2-Tetrachloroethane	79-34-5	600	NL	NL	NL	35,000	**600**
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	40,000,000	NL	NL	NL	100,000	**100,000**
1,1,2-Trichloroethane	79-00-5	1,100	NL	NL	NL	NL	**1,100**
1,1-Dichloroethane	75-34-3	3,600	19,000	240,000	480,000	NL	**3,600**
1,1-Dicholoroethene	75-35-4	230,000	100,000	500,000	1,000,000	NL	**100,000**
1,2,3-Trichlorobenzene	87-61-6	63,000	NL	NL	NL	NL	**63,000**
1,2,4-Trichlorobenzene	120-82-1	24,000	NL	NL	NL	NL	**24,000**
1,2-Dibromo-3-chloropropane	96-12-8	5	NL	NL	NL	NL	**5**
1,2-Dibromoethane	106-93-4	36	NL	NL	NL	NL	**36**
1,2-Dichlorobenzene	95-50-1	1,800,000	100,000	500,000	1,000,000	NL	**100,000**
1,2-Dichloroethane	107-06-2	460	2,300	30,000	60,000	NL	**460**
1,2-Dichloropropane	78-87-5	1,000	NL	NL	NL	NL	**1,000**
1,3-Dichlorobenzene	541-73-1	NL	17,000	280,000	560,000	NL	**17,000**
1,4-Dichlorobenzene	106-46-7	2,600	9,800	130,000	250,000	NL	**2,600**
2-Butanone	78-93-3	27,000,000	100,000	500,000	1,000,000	100,000	**100,000**
2-Hexanone	591-78-6	200,000	NL	NL	NL	NL	**200,000**
4-Methyl-2-pentanone	108-10-1	33,000,000	NL	NL	NL	NL	**33,000,000**
Acetone	67-64-1	61,000,000	100,000	500,000	1,000,000	NL	**100,000**
Benzene	71-43-2	1,200	2,900	44,000	89,000	NL	**1,200**
Bromochloromethane	74-97-5	150,000	NL	NL	NL	NL	**150,000**
Bromodichloromethane	75-27-4	290	NL	NL	NL	NL	**290**
Bromoform	75-25-2	19,000	NL	NL	NL	NL	**19,000**
Bromomethane	74-83-9	6,800	NL	NL	NL	NL	**6,800**
Carbon Disulfide	75-15-0	770,000	NL	NL	NL	100,000	**100,000**
Carbon tetrachloride	56-23-5	650	1,400	22,000	44,000	NL	**650**
Chlorobenzene	108-90-7	280,000	100,000	500,000	1,000,000	NL	**100,000**
Chloroethane	75-00-3	14,000,000	NL	NL	NL	NL	**14,000,000**
Chloroform	67-66-3	320	10,000	350,000	700,000	NL	**320**
Chloromethane	74-87-3	110,000	NL	NL	NL	NL	**110,000**
cis-1,2-Dichloroethene	156-59-2	160,000	59,000	500,000	1,000,000	NL	**59,000**
cis-1,3-Dichloropropene	10061-01-5	NL	NL	NL	NL	NL	**NL**
Cyclohexane	110-82-7	6,500,000	NL	NL	NL	NL	**6,500,000**
Dibromochloromethane	124-48-1	8,300	NL	NL	NL	NL	**8,300**
Dichlorodifluoromethane	75-71-8	87,000	NL	NL	NL	NL	**87,000**
Ethylbenzene	100-41-4	5,800	30,000	390,000	780,000	NL	**5,800**
Isopropylbenzene	98-82-8	1,900,000	NL	NL	NL	100,000	**100,000**
m, p-Xylene *	1330-20-7	580,000	100,000	500,000	1,000,000	NL	**100,000**
Methyl acetate	79-20-9	78,000,000	NL	NL	NL	NL	**78,000,000**
Methyl tert-butyl ether	1634-04-4	47,000	62,000	500,000	1,000,000	NL	**47,000**

Table 4-1a
RI Soil Screening Criteria - VOCs
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY

Volatile Organic Compounds (All units: µg/kg)	CAS Number	Standards					RI Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
Methylcyclohexane	108-87-2	NL	NL	NL	NL	NL	**NL**
Methylene chloride	75-09-2	57,000	51,000	500,000	1,000,000	NL	**51,000**
o-Xylene *	95-47-6	650,000	100,000	500,000	1,000,000	NL	**100,000**
Styrene	100-42-5	6,000,000	NL	NL	NL	NL	**6,000,000**
Tetrachloroethene	127-18-4	24,000	5,500	150,000	300,000	NL	**5,500**
Toluene	108-88-3	4,900,000	100,000	500,000	1,000,000	NL	**100,000**
trans-1,2-Dichloroethene	156-60-5	1,600,000	100,000	500,000	1,000,000	NL	**100,000**
trans-1,3-Dichloropropene	10061-02-6	NL	NL	NL	NL	NL	**NL**
Trichloroethene	79-01-6	940	10,000	200,000	400,000	NL	**940**
Trichlorofluoromethane	75-69-4	23,000,000	NL	NL	NL	NL	**23,000,000**
Vinyl Chloride	75-01-4	59	210	13,000	27,000	NL	**59**

Notes:

1. EPA RSL Summary Table for Resident Soil, (http://www.epa.gov/region9/superfund/prg/) November 2015.
2. NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives, http://www.dec.ny.gov/docs/remediation_hudson_pdf/part375.pdf. December 14, 2006.
3. NYSDEC CP-51/Soil Cleanup Guidance: Table 1 - Supplemental Soil Cleanup Objectives: Residential, http://www.dec.ny.gov/docs/remediation_hudson_pdf/cpsoil.pdf. October 21, 2010.
4. The RI Soil Screening Criteria is selected from the lowest of the EPA and NYSDEC soils standards.

* Criteria are reported for Xylenes in the absence of a separate listed criteria.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
SCO = Soil Cleanup Objectives
RSL = Regional Screening Level
NL = Not listed or chemical name listed but no value available
VOC = volatile organic compound
µg/kg = micrograms per kilogram

Table 4-1b
RI Soil Screening Criteria - SVOCs
Wolff-Alport Chemical Company Site
Ridgewood, NY

Semi-Volatile Organic Compounds (All units: µg/kg)	CAS Number	Standards					RI Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
1,1'-Biphenyl	92-52-4	47,000	NL	NL	NL	NL	**47,000**
1,2,4,5-Tetrachlorobenzene	95-94-3	23,000	NL	NL	NL	NL	**23,000**
1,4-Dioxane	123-91-1	5,300	9,800	130,000	250,000	NL	**5,300**
2,2'-Oxybis (1-chloropropane)	108-60-1	3,100,000	NL	NL	NL	NL	**3,100,000**
2,3,4,6-Tetrachlorophenol	58-90-2	1,900,000	NL	NL	NL	NL	**1,900,000**
2,4,5-Trichlorophenol	95-95-4	6,300,000	NL	NL	NL	100,000	**100,000**
2,4,6-Trichlorophenol	88-06-2	49,000	NL	NL	NL	NL	**49,000**
2,4-Dichlorophenol	120-83-2	190,000	NL	NL	NL	100,000	**100,000**
2,4-Dimethylphenol	105-67-9	1,300,000	NL	NL	NL	NL	**1,300,000**
2,4-Dinitrophenol	51-28-5	130,000	NL	NL	NL	100,000	**100,000**
2,4-Dinitrotoluene	121-14-2	1,700	NL	NL	NL	NL	**1,700**
2,6-Dinitrotoluene	606-20-2	360	NL	NL	NL	1,030	**360**
2-Chloronapthalene	91-58-7	4,800,000	NL	NL	NL	NL	**4,800,000**
2-Chlorophenol	95-57-8	390,000	NL	NL	NL	100,000	**100,000**
2-Methylnapthalene	91-57-6	240,000	NL	NL	NL	410	**410**
2-Methylphenol	95-48-7	3,200,000	100,000	500,000	1,000,000	NL	**100,000**
2-Nitroaniline	88-74-4	630,000	NL	NL	NL	NL	**630,000**
2-Nitrophenol	88-75-5	NL	NL	NL	NL	NL	**NL**
3,3'-Dichlorobenzidine	91-94-1	1,200	NL	NL	NL	NL	**1,200**
3-Nitroaniline	99-09-2	NL	NL	NL	NL	NL	**NL**
4,6-Dinitro-2-methylphenol	534-52-1	5,100	NL	NL	NL	NL	**5,100**
4-Bromophenyl-phenylether	101-55-3	NL	NL	NL	NL	NL	**NL**
4-Chloro-3-methylphenol	59-50-7	6,300,000	NL	NL	NL	NL	**6,300,000**
4-Chloroaniline	106-47-8	2,700	NL	NL	NL	100,000	**2,700**
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	NL	NL	**NL**
4-Methylphenol	106-44-5	6,300,000	34,000	500,000	1,000,000	NL	**34,000**
4-Nitroaniline	100-01-6	27,000	NL	NL	NL	NL	**27,000**
4-Nitrophenol	100-02-7	NL	NL	NL	NL	NL	**NL**
Acenaphthene	83-32-9	3,600,000	100,000	500,000	1,000,000	NL	**100,000**
Acenaphthylene	208-96-8	NL	100,000	500,000	1,000,000	NL	**100,000**
Acetophenone	98-86-2	7,800,000	NL	NL	NL	NL	**7,800,000**
Anthracene	120-12-7	18,000,000	100,000	500,000	1,000,000	NL	**100,000**
Atrazine	1912-24-9	2,400	NL	NL	NL	NL	**2,400**
Benzaldehyde	100-52-7	7,800,000	NL	NL	NL	NL	**7,800,000**
Benzo (a) anthracene	56-55-3	160	1,000	5,600	11,000	NL	**160**
Benzo (a) pyrene	50-32-8	16	1,000	1,000	1,100	NL	**16**
Benzo (b) fluoroanthene	205-99-2	160	1,000	5,600	11,000	NL	**160**
Benzo (g,h,i) perylene	191-24-2	NL	100,000	500,000	NL	NL	**100,000**
Benzo (k) fluoroanthene	207-08-9	1,600	1,000	56,000	110,000	NL	**1,000**
Bis (2-chloroethoxy) methane	111-91-1	190,000	NL	NL	NL	NL	**190,000**
Bis (2-ethylhexyl) phthalate	117-81-7	39,000	NL	NL	NL	50,000	**39,000**

Table 4-1b
RI Soil Screening Criteria - SVOCs
Wolff-Alport Chemical Company Site
Ridgewood, NY

Semi-Volatile Organic Compounds (All units: µg/kg)	CAS Number	Standards					RI Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
bis-(2-chloroethyl) ether	111-44-4	230	NL	NL	NL	NL	**230**
Butylbenzylphthalate	85-68-7	290,000	NL	NL	NL	100,000	**100,000**
Caprolactam	105-60-2	31,000,000	NL	NL	NL	NL	**31,000,000**
Carbazole	86-74-8	NL	NL	NL	NL	NL	**NL**
Chrysene	218-01-9	16,000	1,000	56,000	110,000	NL	**1,000**
Dibenzo (a,h)-anthracene	53-70-3	16	330	560	1,100	NL	**16**
Dibenzofuran	132-64-9	73,000	14,000	350,000	1,000,000	NL	**14,000**
Diethylphthalate	84-66-2	51,000,000	NL	NL	NL	100,000	**100,000**
Dimethylphthalate	131-11-3	NL	NL	NL	NL	100,000	**100,000**
Di-n-butylphthalate	84-74-2	6,300,000	NL	NL	NL	100,000	**100,000**
Di-n-octylphthalate	117-84-0	630,000	NL	NL	NL	100,000	**100,000**
Fluoranthene	206-44-0	2,400,000	100,000	500,000	1,000,000	NL	**100,000**
Fluorene	86-73-7	2,400,000	100,000	500,000	1,000,000	NL	**100,000**
Hexachlorobenzene	118-74-1	210	330	6,000	12,000	410	**210**
Hexachlorobutadiene	87-68-3	1,200	NL	NL	NL	NL	**1,200**
Hexachlorocyclo-pentadiene	77-47-4	1,800	NL	NL	NL	NL	**1,800**
Hexachloroethane	67-72-1	1,800	NL	NL	NL	NL	**1,800**
Indeno (1,2,3-cd)-pyrene	193-39-5	160	500	5,600	11,000	NL	**160**
Isophorone	78-59-1	570,000	NL	NL	NL	100,000	**100,000**
Napthalene	91-20-3	3,800	100,000	500,000	1,000,000	NL	**3,800**
Nitrobenzene	98-95-3	5,100	NL	69,000	140,000	3,700	**3,700**
N-Nitroso-di-n propylamine	621-64-7	78	NL	NL	NL	NL	**78**
N-Nitrosodiphenylamine	86-30-6	110,000	NL	NL	NL	NL	**110,000**
Pentachlorophenol	87-86-5	1,000	2,400	6,700	55,000	NL	**1,000**
Phenanthrene	85-01-8	NL	100,000	500,000	1,000,000	NL	**100,000**
Phenol	108-95-2	19,000,000	100,000	500,000	1,000,000	NL	**100,000**
Pyrene	129-00-0	1,800,000	100,000	500,000	1,000,000	NL	**100,000**

Notes:

1. EPA RSL Summary Table for Resident Soil, (http://www.epa.gov/region9/superfund/prg/) November 2015.
2. NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives, http://www.dec.ny.gov/docs/remediation_hudson_pdf/part375.pdf. December 14, 2006.
3. NYSDEC CP-51/Soil Cleanup Guidance: Table 1 - Supplemental Soil Cleanup Objectives: Residential, http://www.dec.ny.gov/docs/remediation_hudson_pdf/cpsoil.pdf. October 21, 2010.
4. The RI Soil Screening Criteria is selected from the lowest of the EPA and NYSDEC soils standards.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
SCO = Soil Cleanup Objectives
RSL = Regional Screening Level
NL = Not listed or chemical name listed but no value available
SVOC = semi-volatile organic compound
µg/kg = micrograms per kilogram

Table 4-1c
RI Soil Screening Criteria - PCBs (Aroclors)
Wolff-Alport Chemical Company Site
Ridgewood, NY

Aroclors (All units: µg/kg)	CAS Number	Standards				RI Screening Criteria (3)
		Federal	New York			
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	
Aroclor-1016	12674-11-2	4,100	1,000	1,000	25,000	**1,000**
Aroclor-1221	11104-28-2	200	1,000	1,000	25,000	**200**
Aroclor-1232	11141-16-5	170	1,000	1,000	25,000	**170**
Aroclor-1242	53469-21-9	230	1,000	1,000	25,000	**230**
Aroclor-1248	12672-29-6	230	1,000	1,000	25,000	**230**
Aroclor-1254	11097-69-1	240	1,000	1,000	25,000	**240**
Aroclor-1260	11096-82-5	240	1,000	1,000	25,000	**240**
Aroclor-1262	37324-23-5	NL	1,000	1,000	25,000	**1,000**
Aroclor-1268	11100-14-4	NL	1,000	1,000	25,000	**1,000**

Notes:

1. EPA RSL Summary Table for Resident Soil, (http://www.epa.gov/region9/superfund/prg/) November 2015.
2. NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives, http://www.dec.ny.gov/docs/remediation_hudson_pdf/part375.pdf. December 14, 2006.
3. The RI Soil Screening Criteria is selected from the lowest of the EPA and NYSDEC soils standards.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
SCO = Soil Cleanup Objectives
RSL = Regional Screening Level
NL = Not listed or chemical name listed but no value available
PCB = polychlorinated biphenyl
µg/kg = micrograms per kilogram

Table 4-1d
RI Soil Screening Criteria - Pesticides
Wolff-Alport Chemical Company Site
Ridgewood, NY

Pesticides (All units: µg/kg)	CAS Number	Standards					RI Soil Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
4,4'-DDD	72-54-8	2,300	2,600	92,000	180,000	NL	**2,300**
4,4'-DDE	72-55-9	2,000	1,800	62,000	120,000	NL	**1,800**
4,4'-DDT	50-29-3	1,900	1,700	47,000	94,000	NL	**1,700**
Aldrin	309-00-2	39	19	680	1,400	NL	**19**
alpha-BHC	319-84-6	86	97	3,400	6,800	NL	**86**
alpha-Chlordane*	5103-71-9	1,700	910	24,000	47,000	NL	**910**
beta-BHC	319-85-7	300	72	3,000	14,000	NL	**72**
delta-BHC	319-86-8	86	100,000	500,000	1,000,000	NL	**86**
Dieldrin	60-57-1	34	39	1,400	2,800	NL	**34**
Endosulfan*	115-29-7	470,000	NL	200,000	920,000	NL	**200,000**
Endosulfan I	959-98-8	470,000	4,800	200,000	920,000	NL	**4,800**
Endosulfan II	33213-65-9	470,000	4,800	200,000	920,000	NL	**4,800**
Endosulfan sulfate	1031-07-8	470,000	4,800	200,000	920,000	NL	**4,800**
Endrin *	72-20-8	19,000	2,200	89,000	410,000	NL	**2,200**
Endrin aldehyde *	7421-93-4	19,000	2,200	89,000	410,000	NL	**2,200**
Endrin ketone *	53494-70-5	19,000	2,200	89,000	410,000	NL	**2,200**
gamma-BHC (Lindane)	58-89-9	570	280	9,200	23,000	NL	**280**
gamma-Chlordane*	5103-74-2	1,700	NL	NL	NL	540	**540**
Heptachlor	76-44-8	130	420	15,000	29,000	NL	**130**
Heptachlor epoxide	1024-57-3	70	NL	NL	NL	77	**70**
Methoxychlor	72-43-5	320,000	NL	NL	NL	100,000	**100,000**
Toxaphene	8001-35-2	490	NL	NL	NL	NL	**490**

Notes:

1. EPA RSL Summary Table for Resident Soil, (http://www.epa.gov/region9/superfund/prg/) November 2015.
   *Screening value for chlordane is applied to alpha-chlordane and gamma-chlordane.
   *Screening value for alpha-BHC is applied to delta-BHC.
   *Screening value for endosulfan is applied to endosulfan I, endosulfan II, and endosulfan sulfate.
   *Screening value for endrin is applied to endrin aldehyde and endrin ketone.
2. NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives, http://www.dec.ny.gov/docs/remediation_hudson_pdf/part375.pdf.
   *Screening value for chlordane is applied to alpha-chlordane and gamma-chlordane.
   *Screening value for endosulfan is applied to endosulfan I, endosulfan II, and endosulfan sulfate.
   *Screening value for endrin is applied to endrin aldehyde and endrin ketone.
3. NYSDEC CP-51/Soil Cleanup Guidance: Table 1 - Supplemental Soil Cleanup Objectives: Residential, http://www.dec.ny.gov/docs/remediation_hudson_pdf/cpsoil.pdf. October 21, 2010.
4. The RI Soil Screening Criteria is selected from the lowest of the EPA and NYSDEC soils standards.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
SCO = Soil Cleanup Objectives
RSL = Regional Screening Level
NL = Not listed or chemical name listed but no value available
µg/kg = micrograms per kilogram

Table 4-1e
RI Soil Screening Criteria - Inorganics
Wolff-Alport Chemical Company Site
Ridgewood, NY

Inorganics (All units: mg/kg)	CAS Number	Standards					RI Screening Criteria (4)
		Federal	New York				
		EPA RSLs for Residential Soils (1)	NYSDEC Residential Use SCOs (2)	NYSDEC Commercial Use SCOs (2)	NYSDEC Industrial Use SCOs (2)	NYSDEC CP-51 Soil Cleanup Guidance: Residential (3)	
Aluminum	7429-90-5	77,000	NL	NL	NL	NL	**77,000**
Antimony	7440-36-0	31	NL	NL	NL	NL	**31**
Arsenic	7440-38-2	0.68	16	16	16	NL	**0.68**
Barium	7440-39-3	15,000	350	400	10,000	NL	**350**
Beryllium	7440-41-7	160	14	590	2,700	NL	**14**
Cadmium	7440-43-9	71	2.5	9.3	60	NL	**2.5**
Calcium	7440-70-2	NL	NL	NL	NL	NL	**NL**
Chromium*	7440-47-3	NL	NL	NL	NL	NL	**NL**
Cobalt	7440-48-4	23	NL	NL	NL	30	**23**
Copper	7440-50-8	3,100	270	270	10,000	NL	**270**
Cyanide	57-12-5	2.7	27	27	10,000	NL	**2.7**
Iron	7439-89-6	55,000	NL	NL	NL	2000	**2,000**
Lead	7439-92-1	400	400	1,000	3,900	NL	**400**
Magnesium	7439-95-4	NL	NL	NL	NL	NL	**NL**
Manganese	7439-96-5	NL	2000	10,000	10,000	NL	**2,000**
Mercury	7439-97-6	11	0.81	2.8	5.7	NL	**0.81**
Nickel	7440-02-0	1,500	140	310	10000	NL	**140**
Potassium	7440-09-7	NL	NL	NL	NL	NL	**NL**
Selenium	7782-49-2	390	36	1,500	6,800	NL	**36**
Silver	7440-22-4	390	36	1,500	6,800	NL	**36**
Sodium	7440-23-5	NL	NL	NL	NL	NL	**NL**
Thallium	7440-28-0	0.78	NL	NL	NL	NL	**0.78**
Vanadium	7440-62-2	390	NL	NL	NL	100	**100**
Zinc	7440-66-6	23,000	2200	10,000	10,000	NL	**2,200**

Notes:
1. EPA RSL Summary Table for Resident Soil, (http://www.epa.gov/region9/superfund/prg/) November 2015.
2. NYSDEC Subpart 375-6: Table 375-6.8(b): Restricted Use Soil Cleanup Objectives,
3. NYSDEC CP-51/Soil Cleanup Guidance: Table 1 - Supplemental Soil Cleanup Objectives: Residential, http://www.dec.ny.gov/docs/remediation_hudson_pdf/cpsoil.pdf. October 21, 2010.
4. The RI Soil Screening Criteria is selected from the lowest of the EPA and NYSDEC soils standards.
*Chromium based on EPA MCL for total chromium.

Acronyms:
EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
SCO = Soil Cleanup Objectives
RSL = Regional Screening Level
NL = Not listed or chemical name listed but no value available
mg/kg = miiligrams per kilogram

Table 4-2a
RI Groundwater Screening Criteria - VOCs
Wolff-Alport Chemical Company Site
Ridgewood, NY

Volatile Organic Compounds (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)	
1,1,1-Trichloroethane	71-55-6	200	8,000	5	**5**
1,1,2,2-Tetrachloroethane	79-34-5	NL	0.076	5	**0.076**
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	55,000	5	**5**
1,1,2-Trichloroethane	79-00-5	5	0.280	1	**0.28**
1,1-Dichloroethane	75-34-3	NL	2.8	5	**2.8**
1,1-Dicholoroethene	75-35-4	7	280	5	**5**
1,2,3-Trichlorobenzene	87-61-6	NL	7	5	**5**
1,2,4-Trichlorobenzene	120-82-1	70	1.2	5	**1.2**
1,2-Dibromo-3-chloropropane	96-12-8	0	0.00033	0.04	**0.00033**
1,2-Dibromoethane	106-93-4	0	0.00750	0.0006	**0.0006**
1,2-Dichlorobenzene	95-50-1	600	300	3	**3**
1,2-Dichloroethane	107-06-2	5	0.17	0.6	**0.17**
1,2-Dichloropropane	78-87-5	5	0.44	1	**0.44**
1,3-Dichlorobenzene	541-73-1	NL	NL	3	**3**
1,4-Dichlorobenzene	106-46-7	75	0.48	3	**0.48**
2-Butanone	78-93-3	NL	5,600	50	**50**
2-Hexanone	591-78-6	NL	38	50	**38**
4-Methyl-2-pentanone	108-10-1	NL	6,300	NL	**6,300**
Acetone	67-64-1	NL	14,000	50	**50**
Benzene	71-43-2	5	0.46	1	**0.46**
Bromochloromethane	74-97-5	NL	83	5	**5**
Bromodichloromethane	75-27-4	80	0.13	50	**0.13**
Bromoform	75-25-2	80	3.3	50	**3.3**
Bromomethane	74-83-9	NL	8	5	**5**
Carbon Disulfide	75-15-0	NL	810	60	**60**
Carbon tetrachloride	56-23-5	5	0.46	5	**0.46**
Chlorobenzene	108-90-7	100	78	5	**5**
Chloroethane	75-00-3	NL	21,000	5	**5**
Chloroform	67-66-3	80	0.22	7	**0.22**
Chloromethane	74-87-3	NL	190	5	**5**
cis-1,2-Dichloroethene	156-59-2	70	36	5	**5**
cis-1,3-Dichloropropene	10061-01-5	NL	NL	0.4	**0.4**
Cyclohexane	110-82-7	NL	13,000	NL	**13,000**
Dibromochloromethane	124-48-1	80	0.87	50	**0.87**
Dichlorodifluoromethane	75-71-8	NL	200	5	**5**
Ethylbenzene	100-41-4	700	2	5	**1.5**
Isopropylbenzene	98-82-8	NL	450	5	**5**
m, p-Xylene *	1330-20-7	10,000	190	5	**5**
Methyl acetate	79-20-9	NL	20,000	NL	**20,000**
Methyl tert-butyl ether	1634-04-4	NL	14	10	**10**
Methylcyclohexane	108-87-2	NL	NL	NL	**NL**
Methylene chloride	75-09-2	5	11	5	**5**
o-Xylene *	1330-20-7	10,000	190	5	**5**
Styrene	100-42-5	100	1,200	5	**5**
Tetrachloroethene	127-18-4	5	11	5	**5**
Toluene	108-88-3	1,000	1,100	5	**5**
trans-1,2-Dichloroethene	156-60-5	100	360	5	**5**
trans-1,3-Dichloropropene	10061-02-6	NL	NL	0.4	**0.4**
Trichloroethene	79-01-6	5	0.49	5	**0.49**
Trichlorofluoromethane	75-69-4	NL	5,200	5	**5**
Vinyl Chloride	75-01-4	2	0.019	2	**0.019**

Notes:

1. EPA National Primary Drinking Water Standards (web page http://water.epa.gov/drink/contaminants/index.cfm#List), EPA 816-F-09-0004, May 2009.
2. EPA RSL Summary Table for Tap Water, (http://www.epa.gov/region9/superfund/prg/) November 2015.
3. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
   Class Type: Protection for Source of Drinking Water - H(WS)
   Includes April 2000 and June 2004 Addendum values. (http://www.dec.ny.gov/regulations/2652.html)
   Includes revisions in Part 703 effective February 16, 2008.
4. The RI Groundwater Screening Criteria is selected from the lowest of the EPA and NYSDEC groundwater standards.

* Xylene (total) was used for o-xylene and m,p-xylene criteria.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
RSL - regional screening level
VOC = volatile organic compound
µg/L = micrograms per liter
NL = Not listed or chemical name listed but no value available

Table 4-2b
RI Groundwater Screening Criteria - SVOCs
Wolff-Alport Chemical Company Site
Ridgewood, NY

Semi-Volatile Organic Compounds (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)	
1,1'-Biphenyl	92-52-4	NL	0.83	5	**0.83**
1,2,4,5-Tetrachlorobenzene	95-94-3	NL	1.7	5	**1.7**
1,4-Dioxane*	123-91-1	NL	0.46	NL	**0.46**
2,2'-Oxybis (1-chloropropane)	108-60-1	NL	710	5	**5**
2,3,4,6-Tetrachlorophenol	58-90-2	NL	240	NL	**240**
2,4,5-Trichlorophenol	95-95-4	NL	1,200	NL	**1,200**
2,4,6-Trichlorophenol	88-06-2	NL	4.1	NL	**4.1**
2,4-Dichlorophenol	120-83-2	NL	46	5	**5**
2,4-Dimethylphenol	105-67-9	NL	360	50	**50**
2,4-Dinitrophenol	51-28-5	NL	39	10	**10**
2,4-Dinitrotoluene	121-14-2	NL	0.24	5	**0.24**
2,6-Dinitrotoluene	606-20-2	NL	0.049	5	**0.049**
2-Chloronaphthalene	91-58-7	NL	750	NL	**750**
2-Chlorophenol	95-57-8	NL	91	NL	**91**
2-Methylnaphthalene	91-57-6	NL	36	NL	**36**
2-Methylphenol	95-48-7	NL	930	NL	**930**
2-Nitroaniline	88-74-4	NL	190	5	**5**
2-Nitrophenol	88-75-5	NL	NL	NL	**NL**
3,3'-Dichlorobenzidine	91-94-1	NL	0.13	5	**0.13**
3-Nitroaniline	99-09-2	NL	NL	5	**5**
4,6-Dinitro-2-methylphenol	534-52-1	NL	1.5	NL	**1.5**
4-Bromophenyl-phenylether	101-55-3	NL	NL	NL	**NL**
4-Chloro-3-methylphenol	59-50-7	NL	1,400	NL	**1,400**
4-Chloroaniline	106-47-8	NL	0.37	5	**0.37**
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	**NL**
4-Methylphenol	106-44-5	NL	1,900	NL	**1,900**
4-Nitroaniline	100-01-6	NL	3.8	5	**3.8**
4-Nitrophenol	100-02-7	NL	NL	NL	**NL**
Acenaphthene	83-32-9	NL	530	NL	**530**
Acenaphthylene	208-96-8	NL	NL	NL	**NL**
Acetophenone	98-86-2	NL	1,900	NL	**1,900**
Anthracene	120-12-7	NL	1,800	50	**50**
Atrazine	1912-24-9	3	0.3	7.5	**0.3**
Benzaldehyde	100-52-7	NL	1,900	NL	**1,900**
Benzo (a) anthracene	56-55-3	NL	0.012	0.002	**0.002**
Benzo (a) pyrene	50-32-8	0.2	0.0034	NL	**0.0034**
Benzo (b) fluoroanthene	205-99-2	NL	0.034	0.002	**0.002**
Benzo (g,h,i) perylene	191-24-2	NL	NL	NL	**NL**
Benzo (k) fluoroanthene	207-08-9	NL	0.34	0.002	**0.002**
Bis (2-chloroethoxy) methane	111-91-1	NL	59	5	**5**
Bis (2-ethylhexyl) phthalate	117-81-7	6	5.6	5	**5**
Bis (2-chloroethyl) ether	111-44-4	NL	0.014	1	**0.014**
Butylbenzylphthalate	85-68-7	NL	16	50	**16**
Caprolactam	105-60-2	NL	9,900	NL	**9,900**
Carbazole	86-74-8	NL	NL	NL	**NL**
Chrysene	218-01-9	NL	3.4	0.002	**0.002**
Dibenzo (a,h) anthracene	53-70-3	NL	0.0034	NL	**0.0034**
Dibenzofuran	132-64-9	NL	7.9	NL	**7.9**
Diethylphthalate	84-66-2	NL	15,000	50	**50**
Dimethylphthalate	131-11-3	NL	NL	50	**50**
Di-n-butylphthalate	84-74-2	NL	900	50	**50**
Di-n-octylphthalate	117-84-0	NL	200	50	**50**
Fluoranthene	206-44-0	NL	800	50	**50**

Table 4-2b
RI Groundwater Screening Criteria - SVOCs
Wolff-Alport Chemical Company Site
Ridgewood, NY

Semi-Volatile Organic Compounds (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)	
Fluorene	86-73-7	NL	290	50	**50**
Hexachlorobenzene	118-74-1	1	0.0098	0.04	**0.0098**
Hexachlorobutadiene	87-68-3	NL	0.14	0.5	**0.14**
Hexachlorocyclo-pentadiene	77-47-4	50	0.41	5	**0.41**
Hexachloroethane	67-72-1	NL	0.33	5	**0.33**
Indeno (1,2,3-cd) pyrene	193-39-5	NL	0.034	0.002	**0.002**
Isophorone	78-59-1	NL	78	50	**50**
Naphthalene	91-20-3	NL	0.17	NL	**0.17**
Nitrobenzene	98-95-3	NL	0.14	0.4	**0.14**
N-Nitrosodi-n propylamine	621-64-7	NL	0.011	NL	**0.011**
N-Nitrosodiphenylamine	86-30-6	NL	12	50	**12**
Pentachlorophenol	87-86-5	1	0.041	2	**0.041**
Phenanthrene	85-01-8	NL	NL	50	**50**
Phenol	108-95-2	NL	5,800	2	**2**
Pyrene	129-00-0	NL	120	50	**50**

Notes:

1. EPA National Primary Drinking Water Standards (web page http://water.epa.gov/drink/contaminants/index.cfm#List), EPA 816-F-09-0004, May 2009.
2. EPA RSL Summary Table for Tap Water, (http://www.epa.gov/region9/superfund/prg/) November 2015.
3. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
   Class Type: Protection for Source of Drinking Water - H(WS)
   Includes April 2000 and June 2004 Addendum values. (http://www.dec.ny.gov/regulations/2652.html)
   Includes revisions in Part 703 effective February 16, 2008.
4. The RI Groundwater Screening Criteria is selected from the lowest of the EPA and NYSDEC groundwater standards.

* 1,4-Dioxane will be requested for SVOC analysis.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
RSL - regional screening level
SVOC = volatile organic compound
µg/L = micrograms per liter
NL = Not listed or chemical name listed but no value available

Table 4-2c
RI Groundwater Screening Criteria - PCBs (Aroclors)
Wolff-Alport Chemical Company Site
Ridgewood, NY

Aroclors (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)*	
Aroclor-1016	12674-11-2	0.5	0.22	0.09	**0.09**
Aroclor-1221	11104-28-2	0.5	0.0047	0.09	**0.0047**
Aroclor-1232	11141-16-5	0.5	0.0047	0.09	**0.0047**
Aroclor-1242	53469-21-9	0.5	0.0078	0.09	**0.0078**
Aroclor-1248	12672-29-6	0.5	0.0078	0.09	**0.0078**
Aroclor-1254	11097-69-1	0.5	0.0078	0.09	**0.0078**
Aroclor-1260	11096-82-5	0.5	0.0078	0.09	**0.0078**
Aroclor-1262	37324-23-5	0.5	NL	0.09	**0.09**
Aroclor-1268	11100-14-4	0.5	NL	0.09	**0.09**

Notes:

1. EPA National Primary Drinking Water Standards (web page http://water.epa.gov/drink/contaminants/index.cfm#List), EPA 816-F-09-0004, May 2009.
2. EPA RSL Summary Table for Tap Water, (http://www.epa.gov/region9/superfund/prg/) November 2015.
3. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
   Class Type: Protection for Source of Drinking Water - H(WS)
   Includes April 2000 and June 2004 Addendum values. (http://www.dec.ny.gov/regulations/2652.html)
   Includes revisions in Part 703 effective February 16, 2008.
   * Applies to the sum of all polychlorinated biphenyls.
4. The RI Groundwater Screening Criteria is selected from the lowest of the EPA and NYSDEC groundwater standards.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
NYSDEC = New York State Department of Environmental Conservation
RSL - regional screening level
PCB = polychlorinated biphenyl
µg/L = micrograms per liter
NL = Not listed or chemical name listed but no value available

Table 4-2d
RI Groundwater Screening Criteria - Pesticides
Wolff-Alport Chemical Company Site
Ridgewood, NY

Aroclors (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)	
4,4'-DDD	72-54-8	NL	0.032	0.3	**0.032**
4,4'-DDE	72-55-9	NL	0.046	0.2	**0.046**
4,4'-DDT	50-29-3	NL	0.23	0.2	**0.2**
Aldrin	309-00-2	NL	0.00092	NL	**0.00092**
alpha-BHC	319-84-6	NL	0.0072	0.01	**0.0072**
alpha-Chlordane	5103-71-9	2	NL	0.05	**0.05**
beta-BHC	319-85-7	NL	0.025	0.04	**0.025**
delta-BHC	319-86-8	NL	NL	0.04	**0.04**
Dieldrin	60-57-1	NL	0.0018	0.004	**0.0018**
Endosulfan I	959-98-8	NL	NL	NL	**NL**
Endosulfan II	33213-65-9	NL	NL	NL	**NL**
Endosulfan sulfate	1031-07-8	NL	NL	NL	**NL**
Endrin	72-20-8	2	2.3	NL	**2**
Endrin aldehyde	7421-93-4	NL	NL	5	**5**
Endrin ketone	53494-70-5	NL	NL	5	**5**
gamma-BHC (Lindane)	58-89-9	0.2	0.042	0.05	**0.042**
gamma-Chlordane*	5103-74-2	2	NL	0.05	**0.05**
Heptachlor	76-44-8	0.4	0.0014	0.04	**0.0014**
Heptachlor epoxide	1024-57-3	0.2	0.0014	0.03	**0.0014**
Methoxychlor	72-43-5	40	37	35	**35**
Toxaphene	8001-35-2	3	0.071	0.06	**0.06**

Notes:

1. EPA National Primary Drinking Water Standards (web page http://water.epa.gov/drink/contaminants/index.cfm#List), EPA 816-F-09-0004, May 2009.
2. EPA RSL Summary Table for Tap Water, (http://www.epa.gov/region9/superfund/prg/) November 2015.
3. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
   Class Type: Protection for Source of Drinking Water - H(WS)
   Includes April 2000 and June 2004 Addendum values. (http://www.dec.ny.gov/regulations/2652.html)
   Includes revisions in Part 703 effective February 16, 2008.
4. The RI Groundwater Screening Criteria is selected from the lowest of the EPA and NYSDEC groundwater standards.

Acronyms:

EPA = United States Environmental Protection Agency

µg/L = micrograms per liter

CAS = Chemical abstract service

NL = Not listed or chemical name listed but no value available

NYSDEC = New York State Department of Environmental Conservation

RSL - regional screening level

Table 4-2e
RI Groundwater Screening Criteria - Inorganics
Wolff-Alport Chemical Company Site
Ridgewood, NY

Inorganics (All units: µg/L)	CAS Number	Standards			RI Screening Criteria (4)
		Federal		New York	
		EPA National Primary Drinking Water Standards (1)	EPA RSLs for Tap Water (2)	NYSDEC Standards and Guidance Values for Class GA Groundwater (3)	
Aluminum	7429-90-5	NL	20,000	NL	**20,000**
Antimony	7440-36-0	6	7.8	3	**3**
Arsenic	7440-38-2	10	0.052	25	**0.052**
Barium	7440-39-3	2,000	3,800	1,000	**1,000**
Beryllium	7440-41-7	4	25	3	**3**
Cadmium	7440-43-9	5	NL	5	**5**
Calcium	7440-70-2	NL	NL	NL	**NL**
Chromium	7440-47-3	100	NL	50	**50**
Cobalt	7440-48-4	NL	6	NL	**6**
Copper	7440-50-8	1,300	800	200	**200**
Cyanide	57-12-5	200	1.5	200	**1.5**
Iron	7439-89-6	NL	14,000	300	**300**
Lead	7439-92-1	15	15	25	**15**
Magnesium	7439-95-4	NL	NL	35,000	**35,000**
Manganese	7439-96-5	NL	NL	300	**300**
Mercury	7439-97-6	2	0.63	0.7	**0.63**
Nickel	7440-02-0	NL	390	100	**100**
Potassium	7440-09-7	NL	NL	NL	**NL**
Selenium	7782-49-2	50	100	10	**10**
Silver	7440-22-4	NL	94	50	**50**
Sodium	7440-23-5	NL	NL	20,000	**20,000**
Thallium	7440-28-0	2	0.2	0.5	**0.2**
Vanadium	7440-62-2	NL	86	NL	**86**
Zinc	7440-66-6	NL	6,000	2,000	**2,000**

Notes:

1. EPA National Primary Drinking Water Standards (web page http://water.epa.gov/drink/contaminants/index.cfm#List), EPA 816-F-09-0004, May 2009.
2. EPA RSL Summary Table for Tap Water, (http://www.epa.gov/region9/superfund/prg/) November 2015.
3. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
   Class Type: Protection for Source of Drinking Water - H(WS)
   Includes April 2000 and June 2004 Addendum values. (http://www.dec.ny.gov/regulations/2652.html)
   Includes revisions in Part 703 effective February 16, 2008.
4. The RI Groundwater Screening Criteria is selected from the lowest of the EPA and NYSDEC groundwater standards.

Acronyms:

EPA = United States Environmental Protection Agency
µg/L = micrograms per liter
CAS = Chemical abstract service
NL = Not listed or chemical name listed but no value available
NYSDEC = New York State Department of Environmental Conservation
RSL - regional screening level

Table 4-3
RI Screening Criteria - Radiological Analyses
Wolff-Alport Chemical Company Site
Ridgewood, NY

Radionuclide	RI Screening Criteria	Unit	Basis
Solids[1]			
Ra-226	**0.919**	pCi/g	based on 95% UTL from the soil background dataset
Th-232	**1.22**	pCi/g	based on 95% UTL from the soil background dataset
Sediments (creek sediments)			
Ra-226	**0.797**	pCi/g	based on 95% UTL from the sediment background dataset
Th-228	**0.759**	pCi/g	based on 95% UTL from the sediment background dataset
Th-230	**0.697**	pCi/g	based on 95% UTL from the sediment background dataset
Th-232	**0.637**	pCi/g	based on 95% UTL from the sediment background dataset, this value is the lower between the two datasets generated from gamma spectroscopy and isotopic
U-234	**1.279**	pCi/g	based on 95% UTL from the sediment background dataset, excluding outlier
U-235	**0.117**	pCi/g	based on minimum detected concentration from the sediment background dataset since only two results in the dataset were detected
U-238	**1.061**	pCi/g	based on 95% UTL from the sediment background dataset
Aqueous[2]			
Ra-226/Th-232	**5**	pCi/L	Combined Ra-226 and Ra-228 can not exceed 5 pCi/L. In this case the Th-232 is used as a surrogate measure of the Ra-228 likely to be present.
Radon/Thoron			
Radon-Indoors - Basement	**1.2**	pCi/L	Development of screening criteria is based on the 95% UCL calculated from NYSDOH on-going radon data collection study[3].
Radon-Indoors First Floor	**0.5**	pCi/L	Development of screening criteria is based on the 95% UCL calculated from NYSDOH on-going radon data collection study[3].
Radon-Outdoors	**0.1**	pCi/L	Calculated from Weston 2013 Report[4]
Thoron-Outdoors	**0.1**	pCi/L	Calculated from Weston 2013 Report[4] - no indoor data developed so use outdoor data as conservative screening measure
Direct Exposure Rate			
Ground and 3 feet readings	**13**	uR/hr	Upper range of background readings determined by Weston[4]

Notes:
1. Solids will include soils and other materials sampled excluding creek sediments, groundwater, and air samples.
2. 40 CFR.141.15, Maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity in community water system
3. https://health.data.ny.gov/Health/Radon-Test-Results-By-Town-Beginning-1987/hbu9-xsrx
4. - Weston, Perimeter Survey Report, Wolff-Alport Site (Draft September 2013)

Acronyms:

RI - remedial investigation
UTL - upper tolerance limit
UCL - upper confidence limit
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
New York State Department of Health

Ra - radium
Th - thorium
U - uranium

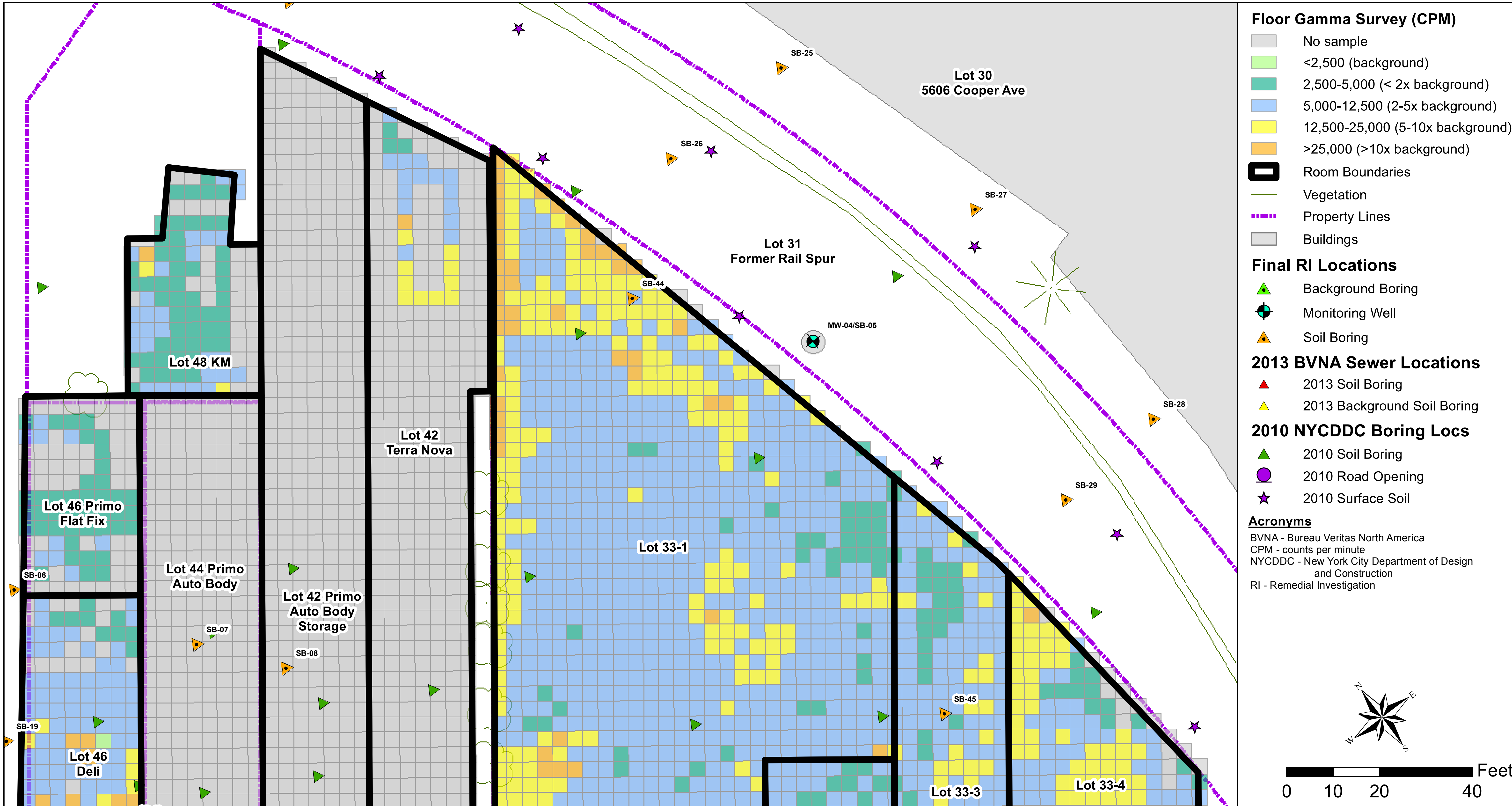


Figure 4-3a
Building Gamma Survey - Floor
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Wall Gamma Survey (CPM)

- <2,500 (background)
- 2,500-5,000 (<2x background)
- 5,000-12,500 (2-5x background)
- 12,500-25,000 (5-10x background)
- >25,000 (>10x background)

Interior Walls
1 Meter Wall Grid
Door
Obstruction

Notes:
Scale - 1 meter = 1 grid unit
All data in counts per minute (CPM)
Material sampling locations designated on map.

Figure 4-3b
Building Gamma Survey - Interior Wall A
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

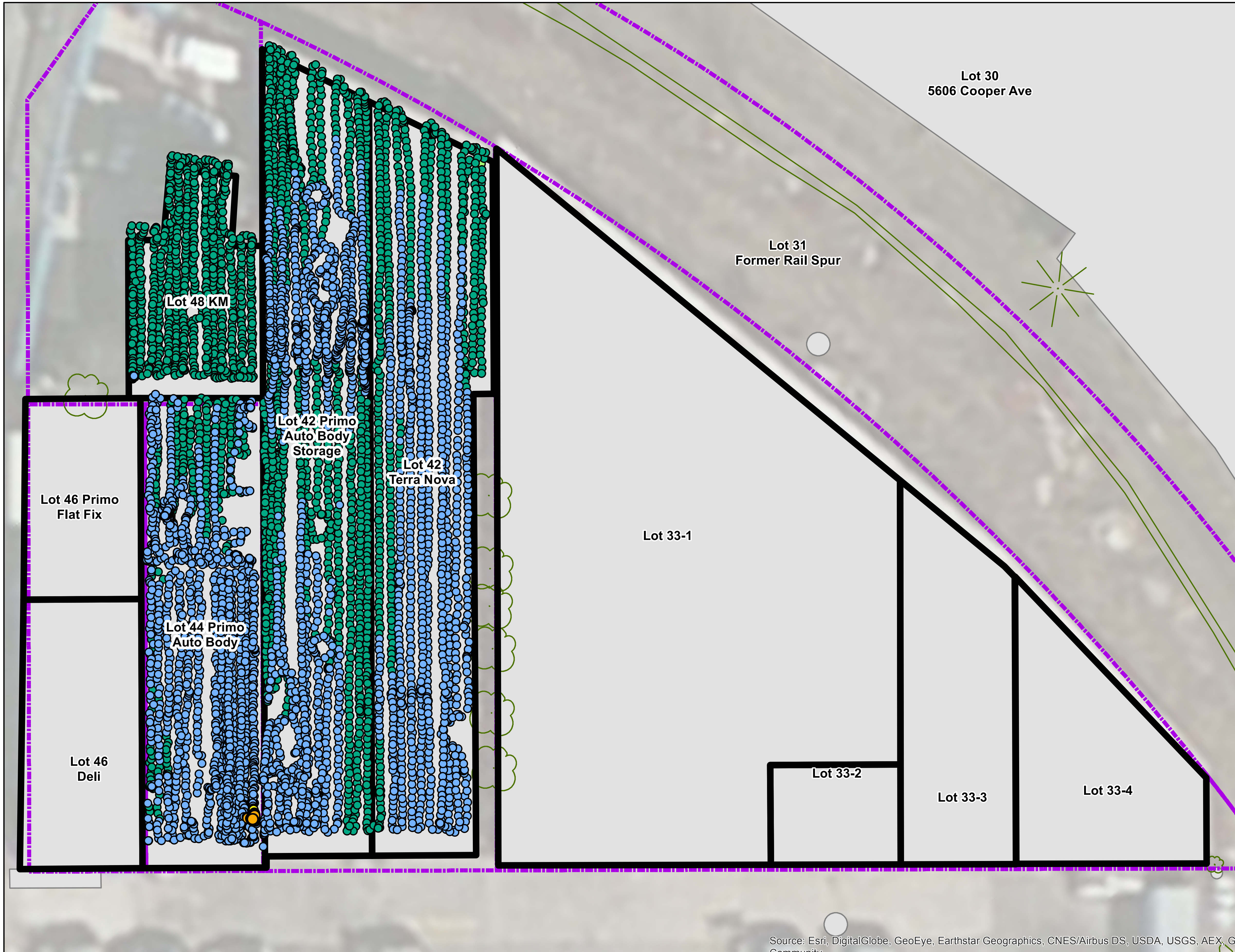
Notes:
Scale - 1 meter = 1 grid unit
All data in counts per minute (CPM)
Material sampling locations designated on map.

Figure 4-3c
Building Gamma Survey - Interior Wall B
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Figure 4-3d
Building Gamma Survey - Ceiling
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



Legend

Roof Gamma Survey (CPM)

- <2,500 (background)
- 2,500-5,000 (<2x background)
- 5,000-12,500 (2-5x background)
- 12,500-25,000 (5-10x background)
- >25,000 (>10x background)
- Room Boundaries
- Vegetation
- Property Lines
- Buildings

Acronyms

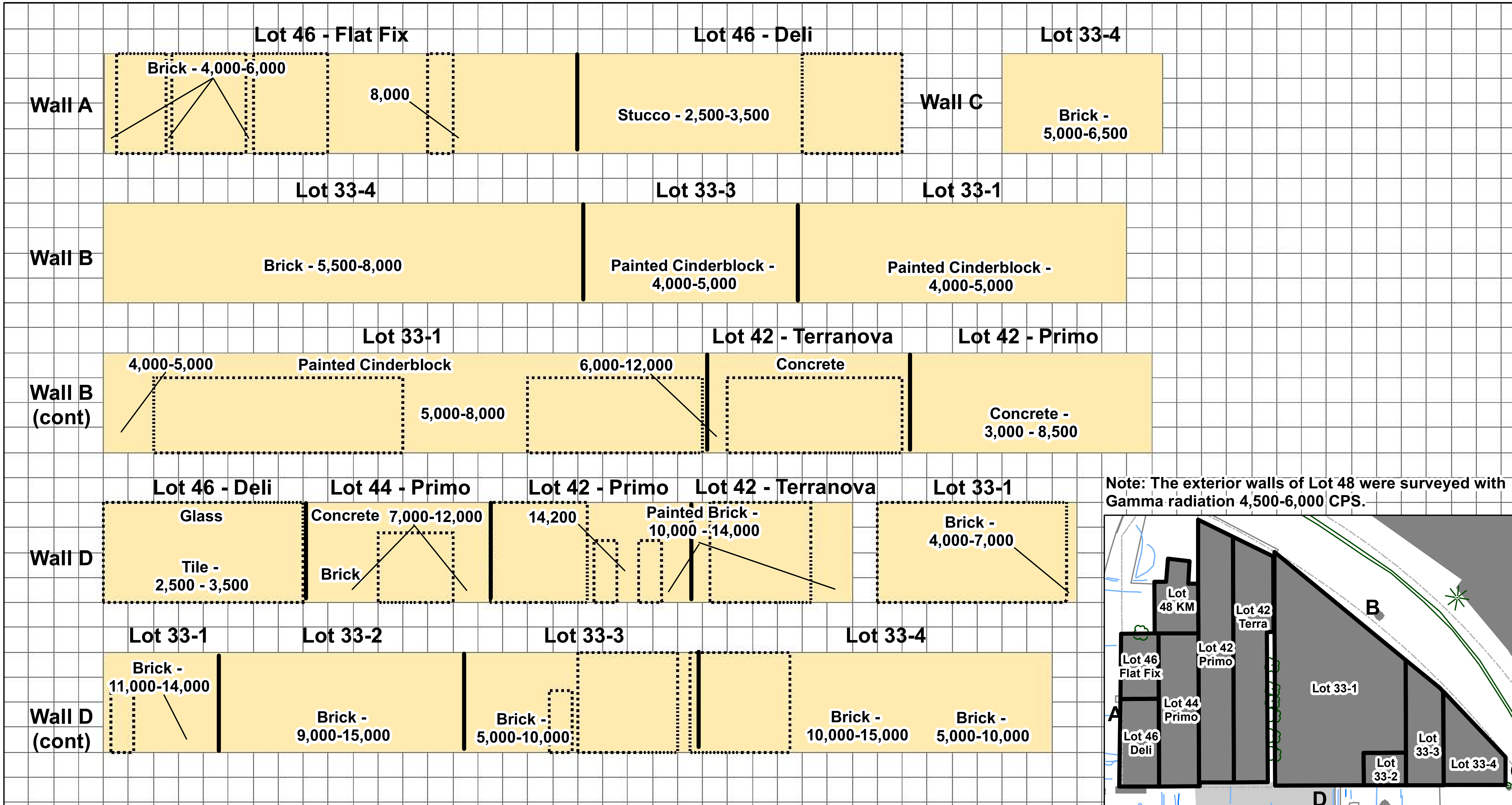
CPM - counts per minute

Feet

0 10 20 40

Figure 4-3e
Building Gamma Survey - Roof
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

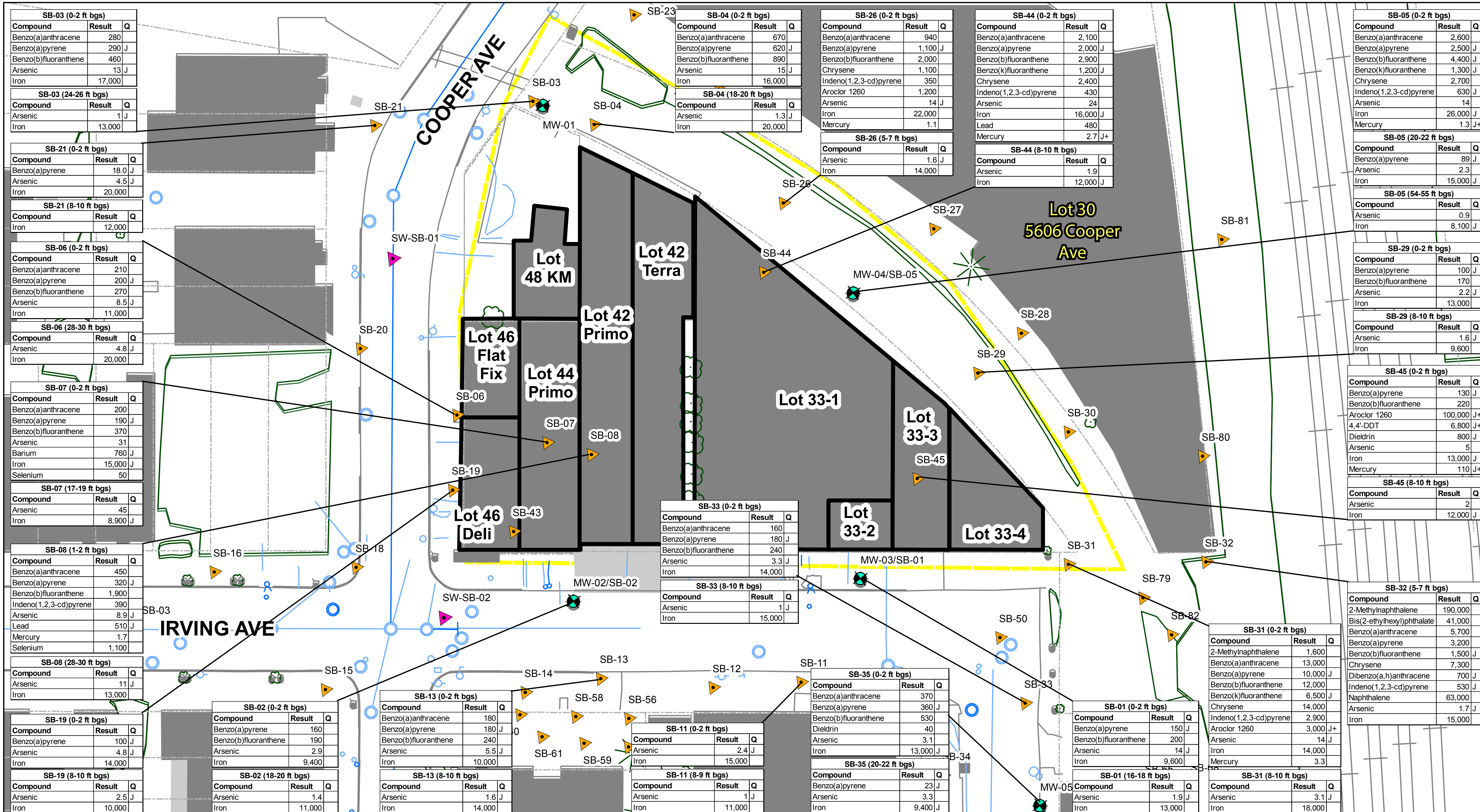


Interior Walls
1 Meter Wall Grid
Door
Obstruction

Scale - 1 meter = 1 grid unit
All data in counts per minute (CPM)
Data collected from bottom two meters of wall only
Ranges represent the majority of data collected per wall area.
The high end of the ranges were measured at the base of the walls.

Figure 4-3f
Building Gamma Survey - Exterior Wall
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



SB-03 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	280	
Benzo(a)pyrene	290	J
Benzo(b)fluoranthene	460	
Arsenic	13	J
Iron	17,000	

SB-03 (24-26 ft bgs)		
Compound	Result	Q
Arsenic	1	J
Iron	13,000	

SB-21 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	18.0	J
Arsenic	4.5	J
Iron	20,000	

SB-21 (8-10 ft bgs)		
Compound	Result	Q
Iron	12,000	

SB-06 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	210	
Benzo(a)pyrene	200	J
Benzo(b)fluoranthene	270	
Arsenic	8.5	J
Iron	11,000	

SB-06 (28-30 ft bgs)		
Compound	Result	Q
Arsenic	4.8	J
Iron	20,000	

SB-07 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	200	
Benzo(a)pyrene	190	J
Benzo(b)fluoranthene	370	
Arsenic	31	
Barium	760	J
Iron	15,000	J
Selenium	50	

SB-07 (17-19 ft bgs)		
Compound	Result	Q
Arsenic	45	
Iron	8,900	J

SB-08 (1-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	450	
Benzo(a)pyrene	320	J
Benzo(b)fluoranthene	1,900	
Indeno(1,2,3-cd)pyrene	390	
Arsenic	8.9	J
Lead	510	J
Mercury	1.7	
Selenium	1,100	

SB-08 (28-30 ft bgs)		
Compound	Result	Q
Arsenic	11	J
Iron	13,000	

SB-19 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	100	J
Arsenic	4.8	J
Iron	14,000	

SB-19 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	2.5	J
Iron	10,000	

SB-04 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	670	
Benzo(a)pyrene	620	J
Benzo(b)fluoranthene	890	
Arsenic	15	J
Iron	16,000	

SB-04 (18-20 ft bgs)		
Compound	Result	Q
Arsenic	1.3	J
Iron	20,000	

SB-26 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	940	
Benzo(a)pyrene	1,100	J
Benzo(b)fluoranthene	2,000	
Chrysene	1,100	
Indeno(1,2,3-cd)pyrene	350	
Aroclor 1260	1,200	
Arsenic	14	J
Iron	22,000	
Mercury	1.1	

SB-26 (5-7 ft bgs)		
Compound	Result	Q
Arsenic	1.6	J
Iron	14,000	

SB-44 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	2,100	
Benzo(a)pyrene	2,000	J
Benzo(b)fluoranthene	2,900	
Benzo(k)fluoranthene	1,200	J
Chrysene	2,400	
Indeno(1,2,3-cd)pyrene	430	
Arsenic	24	
Iron	16,000	J
Lead	480	
Mercury	2.7	J+

SB-44 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	1.9	
Iron	12,000	J

SB-05 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	2,600	
Benzo(a)pyrene	2,500	J
Benzo(b)fluoranthene	4,400	J
Benzo(k)fluoranthene	1,300	J
Chrysene	2,700	
Indeno(1,2,3-cd)pyrene	630	J
Arsenic	14	
Iron	26,000	J
Mercury	1.3	J+

SB-05 (20-22 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	89	J
Arsenic	2.3	
Iron	15,000	J

SB-05 (54-55 ft bgs)		
Compound	Result	Q
Arsenic	0.9	
Iron	8,100	J

SB-29 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	100	J
Benzo(b)fluoranthene	170	
Arsenic	2.2	J
Iron	13,000	

SB-29 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	1.6	J
Iron	9,600	

SB-45 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	130	J
Benzo(b)fluoranthene	220	
Aroclor 1260	100,000	J+
4,4'-DDT	6,800	J+
Dieldrin	800	J
Arsenic	5	
Iron	13,000	J
Mercury	110	J+

SB-45 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	2	
Iron	12,000	J

SB-33 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	160	
Benzo(a)pyrene	180	J
Benzo(b)fluoranthene	240	
Arsenic	3.3	J
Iron	14,000	

SB-33 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	1	J
Iron	15,000	

SB-32 (5-7 ft bgs)		
Compound	Result	Q
2-Methylnaphthalene	190,000	
Bis(2-ethylhexyl)phthalate	41,000	
Benzo(a)anthracene	5,700	
Benzo(a)pyrene	3,200	
Benzo(b)fluoranthene	1,500	J
Chrysene	7,300	
Dibenzo(a,h)anthracene	700	J
Indeno(1,2,3-cd)pyrene	530	J
Naphthalene	63,000	
Arsenic	1.7	J
Iron	15,000	

SB-31 (0-2 ft bgs)		
Compound	Result	Q
2-Methylnaphthalene	1,600	
Benzo(a)anthracene	13,000	
Benzo(a)pyrene	10,000	J
Benzo(b)fluoranthene	12,000	
Benzo(k)fluoranthene	6,500	J
Chrysene	14,000	
Indeno(1,2,3-cd)pyrene	2,900	
Aroclor 1260	3,000	J+
Arsenic	14	J
Iron	14,000	
Mercury	3.3	

SB-31 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	3.1	J
Iron	18,000	

SB-01 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	150	J
Benzo(b)fluoranthene	200	
Arsenic	14	J
Iron	9,600	

SB-01 (16-18 ft bgs)		
Compound	Result	Q
Arsenic	1.9	J
Iron	13,000	

SB-02 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	160	
Benzo(b)fluoranthene	190	
Arsenic	2.9	
Iron	9,400	

SB-02 (18-20 ft bgs)		
Compound	Result	Q
Arsenic	1.4	
Iron	11,000	

SB-13 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	180	
Benzo(a)pyrene	180	J
Benzo(b)fluoranthene	240	
Arsenic	5.5	J
Iron	10,000	

SB-13 (8-10 ft bgs)		
Compound	Result	Q
Arsenic	1.6	J
Iron	14,000	

SB-11 (0-2 ft bgs)		
Compound	Result	Q
Arsenic	2.4	J
Iron	15,000	

SB-11 (8-9 ft bgs)		
Compound	Result	Q
Arsenic	1	J
Iron	11,000	

SB-35 (0-2 ft bgs)		
Compound	Result	Q
Benzo(a)anthracene	370	
Benzo(a)pyrene	360	J
Benzo(b)fluoranthene	530	
Dieldrin	40	
Arsenic	3.1	
Iron	13,000	J

SB-35 (20-22 ft bgs)		
Compound	Result	Q
Benzo(a)pyrene	23	J
Arsenic	3.3	
Iron	9,400	J

Soil Boring Location

Monitoring Wells

Wolff-Alport Property

2010 NYCDDC Borings

2010 Soil Boring

2010 Road Opening

2010 Surface Soil

Notes:
1. Only results exceeding RI screening criteria are presented on this map.
2. Organic results are presented in ug/kg
3. Inorganic results presented in mg/kg

Acronyms:
bgs - below ground surface
ft - feet
J - estimated value
mg/kg - milligram per kilogram
ug/kg - microgram per kiligram
Q - qualifier

N E S W

Feet
0 30 60 120

Figure 4-4
Non-Radiological Soil Screening Criteria Exceedances
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Soil Boring Location
School Soil Boring Location
Sewer Soil Boring Location
Monitoring Wells

2010 NYCDDC Borings
2010 Soil Boring
2010 Road Opening
2010 Surface Soil

2013 BVNA Borings
2013 Soil Boring

WACC Property
Room Boundaries
Vegetation
Property Lines
Buildings

Surface Gamma Scans (CPM)
- <5,000 (background)
- 5,000-10,000 (<2x background)
- 10,000-15,000 (2-3x background)
- 15,000-20,000 (3-4x background)
- >20,000 (>4x Background)

Combined Th-232/Ra-226 Results (pCi/gram)
2015/2016 RI — Historic
- Th-232<1.2 and Ra-226<0.9 (screening criteria)
- Th-232>1.2 or Ra-226>0.9; but combined <5
- 5-20 (~2 to 10x screening criteria)
- 20-50 (~10-25x screening criteria)
- > 50 (>25x screening criteria)

Notes
1. RI Screening criteria:
   Th-232 - 1.2 pCi/gram
   Ra-226 - 0.9 pCi/gram
2. Results of samples are plotted from the RI sampling and historic sampling by NYCDEP (BVNA 2013) and NYCDDC (LBA 2010c) (historic reports included in Appendix A)

Acronyms
BVNA - Bureau Veritas North America
CPM - counts per minute
LBA - Louis Berger Associates
NYCDDC - New York City Department of Design and Construction
NYCDEP - New York City Department of Environmental Protection
pCi/gram - pico curies per gram
RI - Remedial Investigation
WACC - Wolff-Alport Chemical Company

N E S W

0 50 100 200 Feet

Figure 4-5a
Combined Th-232/ Ra-226 Concentrations in Soil
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Sewer Soil Borings

Sewer Survey Locations

- Primary Manholes (fiberscope)
- Secondary Upstream Locs
- Background (potential)
- Manhole not Found

In-Sewer Gamma Scan

Gamma (CPM)

- <5,000 (< background)
- 5,000-10,000 (<2x background)
- 10,000-25,000 (2-5x background)
- 25,000-50,000 (5-10x background)
- >50,000 (>10x background)
- WACC Property
- Room Boundaries
- Vegetation
- Property Lines
- Buildings

Notes

1. Th-232 and Ra-226 results presented in pCi/gram.
2. Gamma exposure rates measured at the road surface and within the manhole vault.
3. Manhole gamma counts measured at the road surface and at the most elevated area within the vault.
4. In-sewer gamma scans are approximate locations.
5. Sewer soil boring sample results are presented for the 2-ft layer of soil showing the highest concentrations of radionuclides.
6. RI Screening criteria for solids:
   Th-232 - 1.2 pCi/gram
   Ra-226 - 0.9 pCi/gram

Acronyms

CPM - counts per minute
pCi/gram - pico curies per gram
RI - Remedial Investigation
WACC - Wolff-Alport Chemical Company
μR/hr - microrem per hour

Figure 4-7
Sewer Investigation Results
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Appendix B

Memorandum

To: *Mr. Thomas Mongelli, EPA Region 2*

From: *Ali Rahmani, CDM Smith*

Date: *July 17, 2017*

Project *EPA Region 2 RAC2 Contract No.: EP-W-009-02*
Work Assignment No.: 054-RICO-A282

Document No.: 3323-054-03291

Subject: *Revised Preliminary Remediation Goals for Radium-226 and Thorium-232 Wolff-Alport Site*

1.0 Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment (WA) 054-RICO-A282 from the United States Environmental Protection Agency (EPA), Region 2 under Remedial Action Contract (RAC) 2 to complete a remedial investigation (RI) and feasibility study (FS) for the Wolff-Alport Chemical Company (WACC) site (Site) located in Ridgewood, Queens County, New York. As part of that effort, EPA Region 2 asked CDM Smith to estimate health risk and radiation dose for a preliminary remediation goal (PRG) of 5 picocuries per gram (pCi/g) for total Radium -226 (Ra-226) and Thorium-232 (Th-232) in soil at the Site. The initial risk assessment and preliminary remediation goals (PRGs) were presented in a March 13, 2017 memorandum[1] from CDM Smith to EPA Region 2.

EPA determined that these PRGs were not consistent with EPA Headquarters policy which dictates use of EPA's PRG calculator[2] rather that the Department of Energy's (DOE) RESRAD[3] model. A follow-up discussion, including a July 6, 2017 conference call between representatives of CDM Smith, EPA Region 2 and EPA Headquarters resulted in an agreement to revise PRGs to be consistent with policy and to better reflect likely future site conditions.

2.0 Recalculation of PRGs

The Human Health Risk Assessment (HHRA) for the site RI considered several exposure pathways for residential exposure to radionuclides. The assessment team decided that ingestion, inhalation and external exposure pathways are pertinent to future site use, and that produce consumption

[1] A. Rahmani, personal communication, (Revised Risk and Dose Estimates for Total Radium (Ra) and Thorium (Th) Activity of 5 pCi/g for the Wolff-Alport Site) to T. Mongelli, March 13, 2017
[2] https://epa-prgs.ornl.gov/radionuclides/
[3] http://resrad.evs.anl.gov/

could be excluded. Produce consumption was eliminated from concern because of the following factors:

1. In an urban environment, produce is more likely to be grown in containers or raised beds and thus, plants would not be impacted by contaminated soil.
2. Even if plants were grown in an urban soil, the soil would need to be considerably amended with top soil, compost, and fertilizers and thus, contaminated soil would in all likelihood be removed before planting occurred.
3. An urban site would have insufficient area needed to grow more than a small fraction of the total produce consumption specified in the PRG calculator.

Recalculation of PRGs for the FS involved some additional evaluation of calculator input parameters. Specifically, site-specific input parameters for area (5,000 square meters [m^2] for site area of approximately 1 acre) and shielding factor[4] of 0.2 in lieu of the 0.4 default could be used to calculate protective PRGs for the Site. PRGs initially estimated by use of the RESRAD, 1 pCi/g for Ra-226 and 4 pCi/g for Th- 232, were used as a soil input to the PRG calculator to determine if risks remain below the upper limit of the EPA risk range of 3×10^{-4}. Results of these calculations are shown in Table 1 below. A full list of input parameters to the PRG calculator is included as Attachment 1 to this memorandum.

Table 1 Site-specific Resident Risk for Soil

Radionuclide	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
Ra-226	6.38E-06	2.6E-08	3.89E-05	4.53E-05
Th-232	1.30E-05	4.07E-07	2.19E-04	2.32E-04
Total Risk	1.94E-05	4.33E-07	2.57E-04	2.77E-04

Typically, the target risk range[5] for determining if a contaminant risk is acceptable/unacceptable is established between 1E-04 and 1E-06. However, in recognition of high risk estimates resulting from low amounts of radionuclides in soil, OSWER[6] 9285.6-20 recommends that risks be commensurate with a radiological dose of 12 millirems per year (mrem/yr) or less. This dose translates into a cancer risk of 3E-04. As can be seen in Table 1 above, the risk value of 2.8E-04 (rounded to two significant figures) is in keeping with that EPA directive.

Note that risk values in Table 1 are derived for the concentration of a radionuclide above its naturally occurring background concentration. In the case of the Wolff-Alport Site the upper range of the background levels based on the 95% Upper Tolerance Limit (UTL) for Ra-226 and Th-232 are 0.92 and 1.2 pCi/g, respectively. Therefore, the inclusion of background establishes the Preliminary Remediation Goal concentrations for Ra-226 and Th-232 at 1.9 pCi/g and 5.2 pCi/g, respectively.

It also should be noted that many exposure parameters used in the analysis lead to conservative (i.e. higher) estimates of dose. Thus, if total residual soil concentrations for Ra-226 and Th-232 are

[4] OSWER 9355-30, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decision (1991)
[5] USEPA, Reassessment of Radium and Thorium Risks Soil Concentrations and Annual Dose Rates (July 1996)
[6] *Distribution of the "Radiation Risk Assessment* at CERCLA Sites: Q&A"

reduced to 1.9 pCi/g and 5.2 pCi/g, respectively, residual risk is likely to be less than the theoretically derived risk of 2.8E-04 and will likely be within the EPA target risk range of 1E-06 to 1E-04.

The residual risk is likely to be less than the theoretically-derived risk of 2.8E-04 because the assumption of no clean soil cover and uniform contamination across the area result in maximizing the theoretical dose. Zoning redevelopment laws require placement of "clean" fill after excavation (i.e. post remediation) work; placement of clean cover reduces exposure for all three exposure pathways considered in this risk assessment. As indicated in Table 1, the external exposure is the dominant risk pathway; with a one-foot soil cover this risk level is reduced by factor of seven and would result in a total risk within the usual remedial action target risk range of 1E-4 to 1E-06.

3.0 Summary

In summary, CDM Smith's reevaluation of PRGs indicates that establishment of the PRGs for Ra-226 and Th-232 at 1.9 pCi/g, and 5.2 pCi/g, respectively, inclusive of local background concentrations, would be protective for the site. Note that where site contaminants exist above background levels, the ratio of Ra-226 to Th-232 is approximately one to four. Thus, setting a remediation concentration requirement of 1.9 pCi/g for Ra-226 and 5.2 pCi/g for Th-232 will help ensure that removal of one component typically leads to removal of the co-contaminant.

EPA PRG calculator outputs and input parameters are shown in Attachment 1 to this memorandum.

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Document Control

Attachment 1

Site-Specific
Resident Equation Inputs for Soil

PRG Calculator Parameter Inputs and Risk Output

Variable	Value
TR (target cancer risk) unitless	3.0E-4
t_{res} (time - resident) yr	26
ED_{res} (exposure duration - resident) yr	26
ET_{res} (exposure time - resident) hr/day	24
ET_{res-c} (exposure time - resident child) hr/day	24
ET_{res-a} (exposure time - resident adult) hr/day	24
ET_{res-i} (exposure time - indoor resident) hr/day	16.416
ET_{res-o} (exposure time - outdoor resident) hr/day	1.752
ED_{res-c} (exposure duration - resident child) yr	6
ED_{res-a} (exposure duration - resident adult) yr	20
EF_{res} (exposure frequency - resident) day/yr	350
EF_{res-c} (exposure frequency - resident child) day/yr	350
EF_{res-a} (exposure frequency - resident adult) day/yr	350
IRS_{res-a} (soil intake rate - resident adult) mg/day	100
IRS_{res-c} (soil intake rate - resident child) mg/day	200
IRA_{res-a} (inhalation rate - resident adult) m^3/day	20
IRA_{res-c} (inhalation rate - resident child) m^3/day	10
$IFS_{res-adj}$ (age-adjusted soil ingestion factor - resident) mg	1120000
$IFA_{res-adj}$ (age-adjusted soil inhalation factor - resident) m^3	161000
GSF_i (gamma shielding factor - indoor) unitless	0.2
Site area for ACF (area correction factor) m^2	5000
Cover thickness for GSF_o (gamma shielding factor) cm	0
Cover thickness for GSF_b (gamma shielding factor) cm	0

Output generated 11JUL2017:09:50:56

Site-Specific
Resident Equation Inputs for Soil

PRG Calculator Parameter Inputs and Risk Output

Variable	Value
TR (target cancer risk) unitless	3.0E-4
ED_{res-c} (exposure duration - resident child) yr	6
ED_{res-a} (exposure duration - resident adult) yr	20
EF_{res-c} (exposure frequency - resident child) day/yr	350
EF_{res-a} (exposure frequency - resident adult) day/yr	350
City (Climate Zone)	20
A_s (acres)	.5
Q/C_{wp} (g/m^2-s per kg/m^3)	87.368977216230
PEF (particulate emission factor) m^3/kg	3232997753.6109
A (PEF Dispersion Constant)	14.0111
B (PEF Dispersion Constant)	19.6154
C (PEF Dispersion Constant)	225.3397
V (fraction of vegetative cover) unitless	0.5
U_m (mean annual wind speed) m/s	4.29
U_t (equivalent threshold value)	11.32
F(x) (function dependant on U_m/U_t) unitless	0.0993

Output generated 11JUL2017:09:50:56

Isotope	Ingestion PRG TR=3.0E-4 (pCi/g)	Inhalation PRG TR=3.0E-4 (pCi/g)	External Exposure PRG TR=3.0E-4 (pCi/g)	Produce Consumption PRG TR=3.0E-4 (pCi/g)	Total PRG TR=3.0E-4 (pCi/g)
**Secular Equilibrium PRG for Ra-226*	*4.70E+01*	*1.02E+05*	*7.71E+00*	-	*6.62E+00*
**Secular Equilibrium PRG for Th-232*	*9.23E+01*	*2.60E+04*	*5.49E+00*	-	*5.18E+00*

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Total Risk
**Secular Equilibrium Risk for Ra-226*	*6.38E-06*	*2.95E-09*	*3.89E-05*	-	*4.53E-05*
**Secular Equilibrium Risk for Th-232*	*1.30E-05*	*4.61E-08*	*2.19E-04*	-	*2.32E-04*
**Total Risk*	*1.94E-05*	*4.91E-08*	*2.57E-04*	-	*2.77E-04*

Appendix C

Appendix C - RESRAD - Determination of Radionuclide Soil and Air Concentrations Resulting in 12 mrem/yr Exposure
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY

Radionuclide	Dose (mrem) at 1 pCi/g	pCi/g to result in 12 mrem/y
Th-232	33.16	0.4
Ra-226	1.86E+01	0.6

	Radon Concentration (pCi/L)		
Radionuclide	Indoor Concentration in pCi/L resulting from 1 pCi/g of listed radionuclide)	Dose (mrem/y)	Exposure Concentration to Result in 12 mrem/y
Ra-226	4.42E-01	3.96E+01	1.34E-01
Th-232	1.30E-03	1.28E-01	1.22E-01

Note: Assumptions to derive relevant concentrations and annual doses are based on HHRA RESRAD input parameters for a Future Resident at the Site.

Appendix D

Appendix D-1
Sewer Pipeline - C and D and Soils Waste Determination
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: JB
JOB NO.: 101995.3323.054	DATE : 5/23/2017	DATE CHECKED: 5/24/2017
CLIENT: EPA		

Description:
The measurements which were input into the dimensional / volumetric calculations below were collected during a sewer fiberscope investigation.

Sewer pipeline

Sewer Pipeline Categories	Length (feet)	Diameter (inches)	Spatial Volume (cubic feet)	Spatial Volume (cubic yards)	Material Volume (cubic feet)	Material Volume (cubic yards)	Tons ($1.9 * yd^3$)
12-inch clay pipe (I-1 to I-4) *Assume wall thickness of 1.25 inches.*	150	12	118	5	26	1	2
15-inch clay pipe (C-1 to I-3) *Assume wall thickness of 1.25 inches.*	200	15	245	10	43	2	4
24-inch reinforced concrete pipeline (I-4 to I-11) *Assume wall thickness of 3 inches.*	855	24	2,686	100	713	27	52
Total volume of pipeline materials				**115**		**30**	**60**

Sewer manholes

Sewer Manholes	Depth (feet)	Inner Diameter (feet)	Wall thickness (inches)	Floor thickness (inches)	Material Volume (cubic feet)	Material Volume (cubic yards)	Tons ($1.9 * yd^3$)
Assume all manholes are alike.							
Assume manholes are cylindrical with brick construction.							
Average depth of manholes to be removed	15	5	9	9	22	1	2
9 manholes to be removed						9	18
Total volume of manhole materials						**10**	**20**

Sewer Soils

Soils	Length (feet)	Width (feet)	Depth (feet)	Volume (cubic feet)	Volume (bank cubic yards)	Volume (loose cubic yards)	Tons ($1.6 * yd^3$)
Assume soils excavated above sewer line are clean.							
Assume width of trench excavation would be 4 feet for pipe diameters 12" - 24".							
Assume width of trench excavation would be 5 feet for pipe diameters 36".							
Assume a soils bulking factor of 25%.							
Non-radiologically Contaminated Soils							
Sewer pipeline from I-1 to I-4 (12")	150	8	11	13,200	489	611	783
Sewer pipeline from C-1 to I-3 (15")	200	8	9	14,400	534	668	855
Sewer pipeline from I-4 to I-11 (24")	855	8	13	88,920	3,294	4,118	5,271
Total non-radiologically contaminated soils					**4,400**	**5,400**	**7,100**
Radiologically Contaminated Soils On Side of Pipeline (subtract volume of pipeline)							
Sewer pipeline from I-1 to I-4 (12")	150	8	1	1,082	41	51	66
Sewer pipeline from I-4 to I-11 (24")	855	8	2	10,994	408	510	653
Sewer pipeline from C-1 to I-3 (15")	200	8	1.25	2,000	75	94	120
Subtotal					*524*	*655*	*839*
Radiologically Contaminated Soils Below Pipeline							
Sewer pipeline from I-1 to I-4 (12")	150	8	0.5	600	23	29	37
Sewer pipeline from I-4 to I-11 (24")	855	8	0.5	3,420	127	159	204
Sewer pipeline from C-1 to I-3 (15")	200	8	0.5	800	30	38	48
Subtotal					*180*	*225*	*288*
Total radiologically contaminated soils					**800**	**880**	**1,300**

Appendix D-1
Sewer Pipeline - C and D and Soils Waste Determination
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	5/23/2017	DATE CHECKED:	5/24/2017
CLIENT:	EPA				

Description:
The measurements which were input into the dimensional / volumetric calculations below were collected during a sewer fiberscope investigation.

Pavement Removal Areas	Surface Area (square feet)	Depth (inches)	Volume (cubic feet)	Volume (cubic yards)	Tons (1.9 * yd^3)
Road Removal					
Road on sewer line	10,000	4	3,333	124	236
Total pavement debris				**200**	**400**

Appendix D-2
Property Buildings - C and D Waste Determination Table
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	5/23/2017	DATE CHECKED:	5/24/2017
CLIENT:	EPA				

Description:
The measurements which were input into the dimensional / volumetric calculations below were collected during a structural inspection at the Wolff-Alport
Assumptions:

Floors are assumed to be radiologically contaminated since they are in contact with the contaminated soils.
Walls are assumed to be radiologically contaminated if high gamma readings were detected during the remedial investigation and the gamma readings.
Gamma readings within the range of background or twice background were not assumed to be contaminated.
Ceilings and the roof were not assumed to be contaminated as the majority of gamma readings were within the range of background. Additionally, the ceiling and roof is not in contact with contaminated materials.

Floor Dimensions

Floor Categories	Length (feet) (front of bldg to back of bldg)	Width (feet) (side to side)	Surface Area (feet)	Thickness (inches)	Volume (cubic feet)	Volume (cubic yards)	Tons (1.9 * yd^3)
Lot 33 (triangular shape)	150	150	12,375	6	6,200	230	440
Subtotal for Lot 33 building						*230*	*440*
Lot 42 (Terra Nova)	152	25	3,800	10	3,200	120	230
Lot 42 (Primo Auto Body)	175	25	4,375	12	4,400	170	330
Lot 44 (Primo Auto)	100	50	5,000	12	5,000	190	370
Lot 46 (Deli/Primo Flat Fix)	100	50	5,000	6	2,500	100	190
Lot 48 (K&M Auto Offices)	irregular shaped		1,145	6	580	30	60
Subtotal						*610*	*1,200*
Total volume of floor materials						**900**	**1,800**

Roof Dimensions

Roof/Ceiling Categories	Length (feet) (front of bldg to back of bldg)	Width (feet) (side to side)	Surface Area (feet)	Thickness (inches)	Volume (cubic feet)	Volume (cubic yards)	Tons (0.027 * yd^3)
Lot 33 (triangular shape)	150	150	12,375	5	4,700	180	5
Subtotal for Lot 33 building						*180*	*5*
Lot 42 (Terra Nova)	152	25	3,800	5	1,500	60	2
Lot 42 (Primo Auto Body)	175	25	4,375	5	1,700	70	0
Lot 44 (Celtic Custom Bike Shop)	100	50	5,000	5	1,900	80	0
Lot 46 (Deli/Primo Flat Fix)	100	50	5,000	5	1,900	80	0
Lot 48 (K&M Auto Offices)	irregular shaped		1,145	5	430	20	0
Subtotal						*310*	*2*
Total volume of roof materials						**500**	**1,000**

Wall Dimensions

Wall Categories	Length (feet) (front of bldg to back of bldg)	Height of Wall (feet)	Surface Area (feet)	Thickness (inches)	Volume (cubic feet)	Volume (cubic yards)	Tons (1.9 * yd^3)
Radiologically Contaminated Walls							
Lot 42 - TerraNova (A)	161	14	2,254	8	1,600	60	120
Lot 42 - TerraNova (B)	30	14	420	8	280	20	40
Lot 42 - TerraNova (C)	150	14	2,100	8	1,400	60	120
Lot 42 - TerraNova (D)	22	14	308	8	210	10	20
Lot 42 - Primo (A)	173	14	2,422	8	1,700	70	140
Lot 42 - Primo (B)	25	14	350	8	240	10	20
Lot 42 - Primo (C)	shared wall						
Lot 42 - Primo (D)	23	14	322	8	220	10	20
Lot 42 - Primo (E)	23	14	322	8	220	10	20
Lot 44 - Primo (A)	100	14	1,400	8	1,000	40	80
Lot 44 - Primo (B)	25	14	350	8	240	10	20
Lot 44 - Primo (C)	shared wall						
Lot 44 - Primo (D)	26	14	364	8	250	10	20
Lot 46 - Deli Basement (D)	57	4	228	8	160	10	20
Subtotal for radiologically contaminated materials						**400**	**800**

Appendix D-2
Property Buildings - C and D Waste Determination Table
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	5/23/2017	DATE CHECKED:	5/24/2017
CLIENT:	EPA				

Wall Dimensions							
Wall Categories	**Length** (feet) (front of bldg to back of bldg)	**Height of Wall** (feet)	**Surface Area** (feet)	**Thickness** (inches)	**Volume** (cubic feet)	**Volume** (cubic yards)	**Tons** (1.9 * yd^3)
Non-radiologically Contaminated Walls							
Lot 46 - Deli - first floor (A) (includes portion of basement wall aboveground)	27	11	297	8	200	10	20
Lot 46 - Deli - first floor (B) (includes portion of basement wall aboveground)	57	11	627	8	420	20	40
Lot 46 - Deli - first floor (C) (includes portion of basement wall aboveground)	27	11	297	8	200	10	20
Lot 46 - Deli - first floor (D) (includes portion of basement wall aboveground)	shared wall						
Non-radiologically Contaminated Walls (cont.)							
Lot 46 - Deli - second floor (A)	27	11	297	8	200	10	20
Lot 46 - Deli - second floor (B)	57	11	627	8	420	20	40
Lot 46 - Deli - second floor (C)	27	11	297	8	200	10	20
Lot 46 - Deli - second floor (D)	57	11	627	8	420	20	40
Lot 46 - Deli Basement (A) (portion below ground, not shared)	27	4	108	8	80	10	20
Lot 46 - Deli Basement (B) (portion below ground, not shared)	57	4	228	8	160	10	20
Lot 46 - Deli Basement (C) (portion below ground, not shared)	27	4	108	8	80	10	20
Lot 46 - Flat Fix (A)	42	7	294	8	200	10	20
Lot 46 - Flat Fix (B)	27	7	189	8	130	10	20
Lot 46 - Flat Fix (C)	shared wall						
Lot 46 - Flat Fix (D)	shared wall						
Lot 48 - KM (A)	34	14	476	8	320	20	40
Lot 48 - KM (B)	28	14	392	8	270	10	20
Lot 48 - KM (C)	shared wall						
Lot 48 - KM (D)	shared wall						
Lot 48 - KM Office (A)	16	12	192	8	130	5	10
Lot 48 - KM Office (B)	14	12	168	8	120	5	10
Lot 48 - KM Office (C)	15	12	180	8	120	5	10
Lot 48 - KM Office (D)	shared wall						
Lot 48 - KM Office (E)	15	12	180	8	120	5	10
Lot 33-1 (A)	153	14	2,142	8	1,500	60	120
Lot 33-1 (B)	112	14	1,568	8	1,100	50	100
Lot 33-1 (C)	60	14	840	8	560	30	60
Lot 33-1 (D)	28	14	392	8	270	10	20
Lot 33-1 (E)	21	14	294	8	200	10	20
Lot 33-1 (F)	51	14	714	8	480	20	40
Lot 33-2 (A)	shared wall						
Lot 33-2 (B)	shared wall						
Lot 33-2 (C)	21	14	294	8	200	10	20
Lot 33-2 (D)	28	14	392	8	270	10	20
Lot 33-3 (A)	shared wall						
Lot 33-3 (B)	32	14	448	8	300	20	40
Lot 33-3 (C)	60	14	840	8	560	30	60
Lot 33-3 (D)	25	14	350	8	240	10	20
Lot 33-4 (A)	shared wall						
Lot 33-4 (B)	59	14	826	8	560	30	60
Lot 33-4 (C)	19	14	259	8	180	10	20
Lot 33-4 (D)	41	14	574	8	390	20	40
Subtotal for Lot 33 building						*320*	*610*
Subtotal for non-radiologically contaminated materials						**600**	**1,200**
Total volume of wall materials						**1,000**	**1,900**

Appendix D-3
Soil Volume Determination
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	5/23/2017	DATE CHECKED:	5/24/2017
CLIENT:	EPA				

Description:
The measurements which were input into the dimensional / volumetric calculations below are based on Figures3-3 through 3-5. The excavation lines were based on Figure 2-1 which illustrates the extent of contamination using soil sampling results from 2010 (Louis Berger and Associates 2010), 2014 (Bureau Vertifies North America), and 2015 (CDM Smith). AutoCAD was used for measurements.
Extents of contamination and excavation plan would be refined during the pre-design investigation as part of the remedial design.

Soil Excavation Areas	Surface Area (square feet)	Depth (feet)	Volume (cubic feet)	Volume (bank cubic yards)	Volume (loose cubic yards)	Tons (1.6 * yd^3)
Assume a soils bulking factor of 25%. Tonnage is calculated based on soil density of banked soils.						
Included in Alternatives 2-4						
SB-80 and SB-82	3,335	2	6,670	250	320	400
SB-56	1,255	2	2,510	100	130	160
B1S3	615	2	1,230	50	70	80
SB-65	250	2	500	20	30	32
Moffat Street	17,630	2	35,260	1,400	1,800	2,240
SWSB-03	1,435	2	2,870	110	140	176
Southeastern corner	7,230	4	28,920	1,100	1,400	1,760
Subtotal				*3,030*	*3,890*	*4,848*
TSCA soils included in radiologically soils excavated						
SB-45	1,150	2	1,165	44	55	80
Included only in Alternatives 2-3						
Moffat St/Irving Avenue Intersection	10,180	4	40,720	1,600	2,000	2,560
SB-35	660	4	2,640	98	130	157
Irving Avenue in front of WACC property	6,145	4	24,580	920	1,150	1,472
Sidewalk in front of Lot 44	690	4	2,760	110	140	176
SB-68	600	4	2,400	90	120	144
SB-67	500	4	2,000	80	100	128
Subtotal	17,675			*9,100*	*11,500*	*15,000*
Alternative 2 only						
Former rail spur area and Lot 33	39,200	2	39,215	1,500	1,900	2,400
Alternative 3 only						
Property and former rail spur area	51,500	2	51,515	2,000	2,500	3,200
Alternative 4 only						
Moffat St/Irving Avenue Intersection	10,180	6	61,080	2,300	2,900	3,680
SB-35	660	8	5,280	200	250	320
Irving Avenue in front of WACC property	7,905	20	158,100	5,900	7,400	9,440
Sidewalk in front of Lot 44	690	30	20,700	770	970	1,232
Property and former rail spur area	44,900	2	44,915	1,700	2,200	2,720
Deep contamination on property	6,600	30	99,225	3,700	4,700	5,920
SB-68	600	6	3,600	140	180	224
SB-67	500	8	4,000	150	190	240
Subtotal				*14,900*	*35,100*	*24,000*
Totals for Each Alternative						
Alternative 2 Excavation Volume	89,725			13,700	17,300	*22,000*
Alternative 3 Excavation Volume	102,025			14,200	17,900	*22,800*
Alternative 4 Excavation Volume	103,785			18,000	39,000	*28,800*
For all alternatives, volume of rad contaminated soils which are TSCA soils				50	60	*100*
Secondary excavation						
Alternative 2					*870*	*1,100*
Alternative 3					*900*	*1,200*
Alternative 4					*2,000*	*1,500*

Appendix D-3
Soil Volume Determination
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	5/23/2017	DATE CHECKED:	5/24/2017
CLIENT:	EPA				

Pavement Removal Areas	Surface Area (square feet)	Depth (inches)	Volume (cubic feet)	Volume (cubic yards)	Tons ($1.9 * yd^3$)
Road Removal					
Moffat St/Irving Avenue Intersection	9,345	4	3,200	120	230
Irving Avenue in front of WACC property	4,915	4	1,700	70	140
Moffat Street	15,430	4	5,200	200	380
SWSB-03	1,434	4	480	20	40
Cooper Avenue	8,299	4	2,800	110	210
Subtotal	39,423			*520*	*900*
Sidewalk Removal					
Irving Avenue sidewalk near WACC (w/ lead and steel shielding)	1,635	6	818	40	80
Irving Avenue sidewalk near WACC (concrete)	835	4	278	20	40
Irving Avenue sidewalk near WACC (asphalt)	479	4	160	10	20
Irving Avenue sidewalk other side from WACC (concrete)	1,440	4	480	20	40
Moffat Street sidewalk (concrete)	3,430	4	1,143	50	100
Subtotal	7,819			*140*	*230*
Total pavement debris				660	1,300

Appendix E

Memorandum

To: *Mr. Thomas Mongelli, EPA Region 2*

From: *Ali Rahmani, CDM Smith*

Project: *EPA Region 2 RAC2 Contract No.: EP-W-009-02*
Work Assignment No.: 054-RICO-A282

Document Control No.: 3323-054-03141

Date: *March 8, 2017*

Subject: *Structural Foundation Inspection of Buildings at Wolf-Alport Chemical Company Site*

1.0 Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment (WA) 054-RICO-A282 from the United States Environmental Protection Agency (EPA), Region 2 under Remedial Action Contract (RAC) 2 to complete a remedial investigation (RI) and feasibility study (FS) for the Wolff-Alport Chemical Company (WACC) site (Site) located in Ridgewood, Queens County, New York. As part of that effort, EPA Region 2 asked CDM Smith to conduct a structural foundation inspection of the buildings located at the Site (**Figure 1**).

2.0 Background

The United States Environmental Protection Agency (EPA), New York State (NYS), and the City of New York (NYC) are working together to reduce potential exposure to radiation caused by contamination as a result of historical operations at the Site. A combination of concrete and lead floor shielding was installed in 2013 to reduce radiation exposures to the occupants of the buildings from the contaminated soils.

The purpose of the WA FS is to identify, develop, screen, and evaluate a range of remedial alternatives for the contaminated media and provide the regulatory agencies with sufficient information to select a feasible and cost-effective remedial alternative that protects public health and the environment from potential risks at the Site.

3.0 Inspection Objective

To help develop and evaluate remedial alternatives for the Site, an inspection of the existing structures at the Site was performed to determine the feasibility of over excavating additional contaminated soil within the buildings to provide additional shielding to reduce the radiation exposure to building occupants. CDM Smith Structures Specialist Paul Blomberg reviewed the site structures on Lots 46, 44, 42, and 33 (**Figure 1**) on February 17, 2017.

The ability to over-excavate additional soils within the structures depends on the size, location and depth of the structural foundations that support the building superstructure. If the structures are supported on shallow foundations, then over-excavation to the base of those shallow foundations is feasible and economical. However, further excavation below the base of shallow foundations would require underpinning of the foundations and the added cost of that work. Should the building be founded on a deep foundation system such as piles or drilled shafts, then available excavation depths would be much deeper without the need for underpinning.

4.0 Structural Discussion, Inspection and Observations

The NYC provided available drawings of the subject buildings, however those drawings are tenant improvement drawings; no structural drawings or original construction drawings are available. To visually identify the foundation systems used for the buildings, a field inspection was performed. As the foundations are buried below grade, the inspection focused on finding areas around or within the building where the foundations were exposed to view. Additionally, a soil sampling auger was used to determine the concrete footing elevation below the surface where accessible.

Each building along Irvine Ave. was visited to determine foundation type, location and depth. Weather during the inspection was sunny, with temperatures in the 30’s °F and 6 inches of snow on the ground. Based on inspection observations, building construction was estimated to have occurred before 1940 with some buildings dating back to the 1920s. Below is a description of the pertinent structural observations of each building.

<u>**Jarabacoa Deli Basement, 11-25 Irving Ave (Block 3725 Lot 46)**</u>

The structure at 11-25 Irving Avenue is a 2-story wood framed building approximately 25 feet (ft) x 100 ft with a full basement, a deli on the first floor and apartments on the second floor. The basement consists of a brick foundation wall and concrete floor. The foundation for the brick foundation wall is unreinforced concrete and is partially exposed. After the building was constructed, it appears that the basement floor was dug out below the top of footing and a concrete slab on grade was cast approximately 8 inches below the adjacent top of footing. The foundation system for this building appears to be a shallow foundation with a continuous concrete strip footing below the unreinforced brick bearing walls. The height of the brick wall is 7 ft-2 inches with 2 inches x10 inches wood floor framing bearing on top of the brick. The floor joists bear directly on the top of the brick wall without a sole plate. Thickness of the basement wall concrete footing could not be determined.

No wall or floor openings were observed that would allow observation of the foundation of the Celtic Custom Bike Shop, 11-27 Irving Ave (Block 3725 Lot 44).

Celtic Custom Bike Shop, 11-27 Irving Ave (Block 3725 Lot 44)

The structure at 11-27 Irving Avenue is a one-story building approximately 25 ft x 100 ft. The roof system is wood framed with brick walls on three sides, concrete masonry unit (CMU) walls to the rear and a concrete slab on grade floor. The floor is raised above the sidewalk level by 6 inches and provides shielding from the soil below. The building is surrounded on three sides by other buildings and open to the street at Irving Ave. The wall to the adjacent Deli (Lot 46) is built with only a several inch gap between the walls and shares a common wall to the southeast with Primo Auto Repair (Lot 42). The end of the building (northeast wall) abuts a one-story commercial building.

Ceilings and wall coverings covered the structural system so no additional observations of the structural system could be made. The foundation system is covered by the new floor slab installed in 2013. No footing information could be observed from the inside of the building. Adjacent buildings obscured any observations of the existing footings from the outside and the concrete sidewalk covered the grade in front of the building. In addition, no access to auger for foundation depth is possible for this building without concrete removal.

Primo Auto Repair, 11-29 Irving Ave (Block 3725 Lot 42)

The structure at 11-29 Irving Avenue is a 1-story building approximately 25 ft x 175 ft. The roof system is wood framed with brick walls and a concrete slab on grade floor. The floor is raised above the sidewalk level by 6 inches and provides shielding from the soil below. The building is surrounded on the two long sides by other buildings and open to the street at Irving Ave and open to the back at the former rail spur (Lot 31). The wall to the adjacent Bike Shop (Lot 44) and Terra Nova (Lot 42) share a common wall with this building. This building has pipe columns within the space along the long walls and steel wide flange beams supporting the roof joists. This indicates that individual footings may be cast below the columns and that the brick walls may not be load bearing. The brick walls likely provide lateral support for the structure. The end of the building (northeast wall) appears to be brick and is stucco covered.

Ceilings and wall coverings covered the structural system and additional observations were not possible. The foundation system is covered by the new floor slab installed in 2013. No footing information could be observed from the inside of the building. Adjacent buildings obscured any observations of the existing footings from the outside and the concrete sidewalk covered the grade in the front and rear of the building. No access to auger for foundation depth is possible for this building without concrete removal.

Terra Nova Restoration Corp., 11-33 Irving Ave (Block 3725 Lot 42)

The structure at 11-33 Irving Avenue is a 1-story building approximately 25 ft x 152ft. The roof system is wood framed with brick walls and a concrete slab on grade floor. The floor is raised above the sidewalk level by 6 inches and provides shielding from the soil below. The building shares a common wall to the northwest with Primo Auto Repair (Lot 42). There is a 5 ft long walkway along the front half of the southeast wall that separates this building from the adjacent Warehouse (Lot 33).

The wall to the adjacent Primo Auto Repair (Lot 42) shares a common wall with this building. This building has pipe columns within the space along the long walls and steel wide flange beams supporting the roof joists. This indicates that individual footings may be cast below the columns and that the brick walls may not be load bearing. The brick walls likely provide lateral support for the structure. The end of the building (northeast wall) appears to be brick and is stucco covered.

Ceilings and wall coverings covered the structural system so no additional observations of the structural system could be made. Exterior access along the 5' walkway adjacent to the Warehouse (Lot 33) was inaccessible due to the area being barricaded, overgrown with vegetation and covered with snow. The foundation system is covered by the new floor slab installed in 2013. No footing information could be observed from inside the building. Adjacent buildings obscured any observations of the existing footings from the outside and the concrete sidewalk covered the grade in the front and rear of the building. No access to auger for foundation depth is possible for this building without concrete removal.

<u>Warehouse, 11-33 to 11-99 Irving Ave (Block 3725 Lot 33)</u>

The warehouse structure is a 1-story steel framed building with a triangular footprint. Frontage (Irving Ave.) dimension is approximately 150 ft by 150 ft deep to the north corner with the back-wall curving along former rail spur (Lot 31) approximately 225 ft. The superstructure is steel wide flange columns and masonry pilasters with steel wide flange roof framing and an unknown roof system. Exterior walls are CMU with some exterior brick façade. The floor is cast in place concrete and appeared to be original to the structure. The foundation system for this building was not visible from the interior. The rear of the building along the former rail spur (Lot 31) was accessed and a hand-held auger was used to core the soil along the exterior wall. Auger refusal occurred at 24 inches below grade and this appears to be the top of the concrete foundation for this building. The spoils from the core were placed back in the hole and the grade was re-covered with snow.

5.0 Conclusion

The ability to over-excavate additional soils within the structures depends on the size, location and depth of the structural foundations that support the building superstructure. Available building drawings were reviewed but none indicated original construction information nor any information on the existing foundations. Visual inspection of the subject buildings and the adjacent buildings were not able to identify the foundation systems, their size or elevations as all were buried beneath grade and inaccessible.

Foundation depth is currently required by the Building Code to be 48" below grade but this requirement may or may not have been in force when these buildings were constructed. Over-excavation of the existing soils below the building concrete slabs on grade is feasible as long as the excavation does not undermine the existing footings. Excavation to the bottom of the footing elevation is an available option but further testing would be needed to determine this elevation.

It appears that a reasonable assumption for FS alternative development is that depth of footing is 24 to 30 inches below grade as the adjacent Warehouse building occurs at that elevation. Any remedy that includes soil excavation to provide additional shielding to reduce the radiation exposure to building occupants will need footing size and elevations verified. This can be accomplished during pre-remedial design activities by coring/selective excavation or ground penetrating radar.

cc: Joel Singerman, EPA
Tony Isolda, CDM Smith
Paul Blomberg, CDM Smith
Jeanne Litwin, CDM Smith
Kavitha Subramaniam, CDM Smith
Document Control

HEALTH AND SAFETY PLAN FORM CDM Smith Health and Safety Program	*This document is for the exclusive use of CDM Smith and its subcontractors*	CDM Smith Project Document # 3323-054-02470

SITE MAP: *Boundary of former WACC Operations*

Appendix F

Appendix F-1
Cost Estimate for Alternative 2
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

No.	Description	Cost
	Remedial Action	
01	Temporary and permanent relocation	$982,000
02	General requirements	$2,876,000
03	Site preparation/site work	$336,000
04	Lead and steel installation in Lots 42, 44, 46 and sidewalk	$3,391,000
05	Demolition and segregation	$77,000
06	Excavation and segregation	$562,508
07	Post-excavation sampling	$50,000
08	Sewer line excavation, removal, and replacement	$5,037,000
09	Other impacted buildings excavation and restoration	$44,000
10a	Transportation and disposal costs	$11,918,000
10b	Transportation and disposal labor	$49,000
11	Restoration and Final Status Survey	$1,012,000
	Subtotal for Construction Activities	*$13,435,000*
	Subtotal for Transportation and Disposal	*$11,918,000*
	Contingency on Construction Activities (20%)	$2,687,000
	Contingency on Transportation and Disposal (20%)	$2,384,000
	Subtotal for Construction Activities	*$16,122,000*
	Subtotal for Transportation and Disposal	*$14,302,000*
	General Contractor Bond and Insurance - Construction Activities (5%)	$807,000
	General Contractor Bond and Insurance - Transportation and Disposal (5%)	$716,000
	Subtotal for Construction Activities	*$16,929,000*
	Subtotal for Transportation and Disposal	*$15,018,000*
	General Contractor Markup - Construction Activities (10%)	$1,693,000
	General Contractor Markup - Transportation and Disposal (2%)	$301,000
	Subtotal of Remedial Action Construction Activities	$18,622,000
	Subtotal of Remedial Action Transportation and Disposal	$15,319,000
	Subtotal of Relocation	$982,000
12	**OPERATION AND MAINTENANCE COSTS**	
	Annual Inspection and Maintenance for Radon Mitigation System, Radon Monitoring, and Groundwater Monitoring	$109,000
	Present Worth for Inspection and Maintenance (30 Years)	$1,353,000
	PRESENT WORTH	
	Total Capital Cost (including relocation)	**$34,923,000**
	Total O&M Cost	**$1,353,000**
	Total Present Worth	**$36,276,000**

Note: The project cost presented herein represents only feasibility study level, and is thus, subject to change pending the results of the pre-design investigation, which is intended to collect sufficient data to assist in the development of remedial design and associated detailed cost estimate. Expected accurant range of the cost estimate is -30% to +50% ($25,393,200 to $54,414,000).
The estimate is prepared solely to facilitate relative comparisons between feasibility study alternatives for evaluation.
The costs do not include costs for project management and construction management, remedial design, pre-design investigation, or relocation.
Reference: EPA. A Guide to Developing Cost Estimates During the Feasibility Study. 540-R-00-002. July 2000.

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

01 - Temporary and Permanent Relocation

Block	Lot	Owner	Tenant	Address
3725	33	Unique Development	Empty warehouse, no tenant	11-33 Irving Avenue
	42	LPL Properties, Inc.	Primo Auto Body and TerraNova	11-29 Irving Avenue
	44	LPL Properties, Inc.	Celtic Bike Shop	11-27 Irving Avenue
	46	Second A-One	Jarabacoa Deli	11-25 Irving Avenue
	48	Rudy Reyes	K&M Auto Repair	15-14 Cooper Avenue

Temporary Relocation for Tenants of Lot 42, 44, 46, and 48

Costs are estimated following 49 CFR 24 - Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs.
Costs are estimated based on relocation costs incurred at another Ragion 2 Superfund Site in the tri-state area.
Estimate for incremental rent is based on an increase of $500 in rent per month for two years.

	Quantity	Unit	Unit Cost		Extended Cost
Reestablishment Costs	5	each	$25,000	=	$125,000
Search expenses	5	each	$2,500	=	$12,500
Related expenses, first move	5	each	$25,000	=	$125,000
Related expenses, return move	5	each	$25,000	=	$125,000
Incremental rent for 42 months	5	each	$21,000	=	$105,000
Moving expenses, first move	5	each	$40,000	=	$200,000
Moving expenses, return move	5	each	$40,000	=	$200,000
				Subtotal	**$892,500**
Admininistration costs	1	LS	$89,250	=	**$89,250**
TOTAL COST FOR TEMPORARY AND PERMANENT RELOCATION					**$982,000**

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02 - General Requirements

Project Schedule

Assume the following construction schedule.

Pre-construction work plans and meetings	3	months	13	weeks
Construction Period				
Field mobilization and site preparation	1	months	5	weeks
Building demolition	1	months	5	weeks
Soil excavation (including roadway)	3	months	13	weeks
Sewer line excavation, removal, and replacement	5	months	22	weeks
Site restoration and demobilization	2	months	9	weeks
Total construction duration	*12*	*months*	*52*	*weeks*
Total project duration in months	**15**	**months**		
Total project duration in weeks	**65**	**weeks**		

General Conditions

A) Project Management and Site Supervisory

Assume the following staff for the duration of project with Project Manager at 16 hours/week, Project Engineer at 20 hours/week, and procurement staff at 10 hours/week.

	Quantity	Unit	Unit Cost		Extended Cost
Project Manager	1,040	hr	$150	=	$156,000
Project Engineer	1,300	hr	$110	=	$143,000
Procurement staff	650	hr	$90	=	$58,500
Scheduler	120	hr	$100	=	$12,000
Total management and office support					$369,500

B) Work Plan Preparation

Estimated # of Pre-Construction Work Plans Required:	15	work plans
Estimated # of Engineer Hours Required per Work Plan:	60	hours each
Estimated # of Project Manager Hours Required per Work Plan:	2	hours each

Project Engineer	900	hr	$110	=	$99,000
Project Manager	15	hr	$150	=	$2,250
Total Work Plan Preparation Cost					$101,250

C) Remedial Action Report

Project Engineer	400	hr	$110	=	$44,000
Project Manager	60	hr	$150	=	$9,000
Total Remedial Action Report Preparation Cost					$53,000

C) Permits

Permit Specialist	250	hr	$125	=	$31,250
Project Manager	120	hr	$150	=	$18,000
Total Permitting Cost					$49,250

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

02 - General Requirements

D) Onsite supervisory

Assume the following full time site supervisory staff for the duration of construction.

Assume 40 hours per week.

Assume construction foreman would be local and not require a truck.

Site Superintendent	2,080	hr	$150	=	$312,000
Construction Foreman	2,080	hr	$100	=	$208,000
Onsite QC Engineer	2,080	hr	$110	=	$228,800
Pickup Truck #1	260	day	$100	=	$26,000
Pickup Truck #2	260	day	$100	=	$26,000
Total Onsite Supervisory Staff for Total Construction Duration (52 weeks)					$800,800
Subtotal General Conditions:					**$1,374,000**

Safety and Health Requirements

Safety and Health Requirements to include the Site Health and Safety Officer (SHSO)/Medium level health physicist, personnel protective equipment and supplies, and additional safety and air monitoring equipment/testing.

Assume PPE required for 20 people per work day for the duration of construction activities.

The radiological services cost are used from the remedial investigation bid sheet accounting for 3% escalation.

Assume senior health physicist time at 8 hours per month.

Assume a crew of 20 would be onsite.

SHSO/Med. Health Physicist	2080	hr	$62	=	$128,128
Junior Technician	2080	hr	$50	=	$104,832
Senior Health Physicist	96	hr	$112	=	$10,752
Equipment					
SKC PCXR4 lapel sampling pumps	12	month	$720	=	$8,640
Bios Defender calibrator	12	month	$200	=	$2,400
Ludlum 2929/43-10-1 alpha/beta sample counter	12	month	$480	=	$5,760
Ludlum 2360/43-93 alpha beta field meters	12	month	$720	=	$8,640
Ludlum model 2221/44-9 alpha/beta/gamma probe	12	month	$225	=	$2,700
Ludlum Model 9P pressurized ion chamber survey met	12	month	$200	=	$2,400
Work area air monitor	12	month	$165	=	$1,980
perimeter radiological air monitoring stations	12	month	$2,500	=	$30,000
Dust monitors	12	month	$1,450	=	$17,400
Filter media, smear consumables	12	month	$50	=	$600
Radiation Badges	1200	each	$39	=	$47,040
PPE	260	day	$140	=	$728,000
Additional Safety and Air Monitoring Equipment			10%	=	$72,800
					$1,172,072

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

02 - General Requirements

Temporary Facilities

Temporary Facilities to include work space, utilities, cleaning services, and office equipment and supplies.

Assume work space rental instead of trailers due to limited space available at the site.

Reference - RS Means 01 52 20 Construction Facilities for 2017 in Queens, NY.

Work space rental	12	month	$2,000	=	$96,000
Electricity	12	month	$177	=	$8,496
Electricity hookup	1	LS	$10,000	=	$10,000
Phone/Internet	12	month	$95	=	$1,140
Water/Sewer	12	month	$60	=	$720
Cleaning service and others	12	month	$300	=	$3,600
					$119,956

Security

Assume for duration of construction requires 16-hour security guard for weekdays and 24-hour security guard for weekends for the entire field

Security trailer rental	12	month	$200	=	$2,400
Security guard	6,912	hours	$30	=	$207,360
					$209,760

TOTAL COST FOR GENERAL REQUIREMENTS	**$2,876,000**

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03 - Site Work

Assume cars and mechanic-related materials will be removed from the property as part of relocation.
Assume staging area for demolition will be in the former rail spur area.
Assume excavation will be completed in phases to account for the limited site area.

Clearing and Grubbing

Assume clearing in the former rail spur area.
Assume staging area will be in the former rail spur area.
Reference - RS Means 31 11 1010 0010 Clear and Grub Site for 2017 in Queens, NY.

	Quantity	Unit	Unit Cost		Extended Cost
Clearing and grubbing	22,000	SF	$0.10	=	$2,200

Mobilization of Construction Equipment

Field mobilization (allowance)	1	LS	$75,000	=	$75,000

Surveying

Survey would be conducted duration excavation and sewer line removal.

Surveyor onsite during sewer removal and excavation period (for depth verification, quantity measurement, waste char. samples).
Assume surveyor time at 10 hours per week.

Total Surveying Duration 35 weeks

	Quantity	Unit	Unit Cost		Extended Cost
Professional Surveyor	40	hr	$120	=	$4,800
Surveyor	350	hr	$75	=	$26,250
Assistant Surveyor	350	hr	$65	=	$22,750
Submittals	1	LS	$20,000	=	$20,000
Subtotal					$73,800

Erosion Control

Assume daily output of silt fencing at 1,300 LF and hay bales at 2,500 LF.
Reference - RS Means 31 25 1416 1000 for 2017 in Queens, NY
Reference - RS Means 31 25 1416 1250 Clear and Grub Site for 2017 in Queens, NY

Total excavation and backfill duration 44 weeks
Length of erosion control measure 1500 LF

	Quantity	Unit	Unit Cost		Extended Cost
Silt fence	1500	LF	$2.44	=	$3,660
Hay bale	1500	LF	$7.15	=	$10,725
Maintenance (10%)	44	month	$366.00	=	$16,104
Subtotal					$30,489

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

03 - Site Work

Decontamination

Assume decontamination pad required during construction.

Assume decontamination water will be used for dust suppression.

Duration of construction			40 weeks		
	Quantity	Unit	Unit Cost		Extended Cost
Construction of decontamination pad					
	1	LS	$10,000	=	$10,000
Decontamination operation					
Assume 2 workers for 2 hours per day to perform equipment decontamination on-site including T&D trucks.					
Laborers (2)	400	hr	$120	=	$48,000
Assume 15 trucks per day at 20 gallons per truck of steam cleaning.					
Assume 55-gallon drums filled to 50 gallons.					
Decon water produced	300	gals/day	60,000	gallons	
Drums	1,200	drum	$80	=	$96,000
Subtotal					$154,000
TOTAL COST FOR SITE WORK					**$336,000**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

04 - Installation of lead shielding in Lots 42, 44, 46, and the sidewalk

See Appendix A-1 for surface area of building calculations.
Assume lead and stell installation will occur concurrently with other construction activities.

Floor/wall surface area of buildings		
Lot 44 floor surface area	5,000	SF
Lot 42 (Primo) floor surface area	4,375	SF
Lot 42 (TerraNova) floor surface area	3,800	SF
Lot 46 basement wall border soils under Lot 44	228	SF
Sidewalk	1,756	SF
Total surface area	15,159	SF

Assume 1/2-inch lead shielding layered for a total of 1-inch lead shielding and 1-inch steel plating.
Assume daily output of lathing at 120 SF per 2 lathers.
Reference - RS Means 13 49 1350 0500 for 2017 in Queens, NY
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Installation duration							
Duration (lead)	30,318	SF	600	SF/day	=	51	days
Duration (steel)	15,159	SF	600	SF/day	=	26	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Lathers (10 lathers, 5 crews)	77	day	$3,265	=	$251,395
Materials					
Lead sheet is 18 square meters.					
Lead sheet	30,318	SF	$76	=	$2,289,009
Lead-headed nails	156	lb	$8	=	$1,260
Steel sheet (including connections)	15,159	SF	$56	=	$848,904

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**77 days**
TOTAL COST FOR LEAD AND STEEL INSTALLATION	**$3,391,000**

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05 - Building Demolition and Construction Debris Disposal

Building is a mixture of steel, concrete, and masonry.
Assume building foundation is 6-inch concrete with reinforced rods.
Assume building demolition rate of 20100 CF per day.
Assume foundation demolition rate of 4000 CF per day.

Building Demolition - Lot 33

Standing building volume

Building footprint	12,375	SF
Building height	14	LF
Volume of building	173,250	CF

Assume 6-inch concrete, reinforced rods foundation.

Building foundation volume

Building footprint	12,375	SF
Foundation thickness	0.5	feet
Volume of building	6,188	CF

Asbestos and Lead Paint Abatement

An initial hazardous building materials survey was completed for the site and found asbestos and lead at volume typical of a building at this age.

Asbestos Abatement	1	LS	$5,000	=	$5,000
Lead paint abatement	1	LS	$2,500	=	$2,500

Demolition of standing building

Reference - RS Means 02 41 1613 0100 for 2017 in Queens, NY
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	173,250	CF	20,100	CF/day	=	9	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	9	day	$467	=	$4,207
Laborers (2)	9	day	$889	=	$8,005
Equip. Oper. (medium) (2)	9	day	$1,217	=	$10,950
Equip. Oper. (oiler)	9	day	$545	=	$4,908
Hyd. Excavator (3.5 CY)	9	day	$2,401	=	$21,609
Hydraulic Crane (25 ton)	9	day	$674	=	$6,064

Demolition of slab foundation

Assume footings would be removed as part of the excavation.
Reference - RS Means 02 41 1617 0400 for 2017 in Queens, NY
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	12,375	SF	4,000	SF/day	=	4	days

CDM Smith

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

05 - Building Demolition and Construction Debris Disposal

Labor and Equipment					
Equip. Oper. (heavy) (2)	4	day	$1,266	=	$5,062
Hyd. Excavator, 1.5 CY	4	day	$965	=	$3,860
Hyd. Hammer (5,000 lbs)	4	day	$376	=	$1,505
Hyd. Excavator, 0.75 CY	4	day	$674	=	$2,697

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**13 days**
TOTAL COST FOR BUILDING DEMOLITION	**$77,000**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

06 - Soils Excavation

Road Removal

Assume road has 4 inch depth.

See Figure 3-3 for areas of road to remove.

Total area of roadway to remove 39,423 SF

4,390 SY

Removal Duration

Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY

Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration - conc	4,390	SY	200	SY/day	=	22	days
Duration - asph	4,390	SY	420	SY/day	=	11	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	33	day	$467	=	$15,426
Laborers (2)	33	day	$889	=	$29,353
Equip. Oper (light)	33	day	$579	=	$19,119
Equip. Oper. (medium)	33	day	$608	=	$20,075
Backhoe loader (48 HP)	33	day	$366	=	$12,085
Hyd. Hammer (1200 lbs)	33	day	$182	=	$6,013
Front end loader (4 CY)	33	day	$658	=	$21,701
Pavement rem. bucket	33	day	$58	=	$1,907
Subtotal				=	**$125,679**

Sidewalk Removal

Assume sidewalk has 6 inch depth.

See Figure 3-3 for areas of sidewalk to remove.

Total volume of sidewalk to remove 7,819 SF

870 SY

Removal Duration

Reference - RS Means 02 41 1317 5200 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	870	SY	255	SY/day	=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (2)	4	day	$889	=	$3,558
Equip. Oper (light)	4	day	$579	=	$2,317
Equip. Oper. (medium)	4	day	$608	=	$2,433
Backhoe loader (48 HP)	4	day	$366	=	$1,465
Hyd. Hammer (1200 lbs)	4	day	$182	=	$729
Front end loader (4 CY)	4	day	$658	=	$2,630
Pavement rem. bucket	4	day	$58	=	$231
Subtotal				=	**$15,234**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

06 - Soils Excavation

Fencing to secure excavation

Perimeter requiring fencing 1,995 LF

Fencing installation duration

Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration 1,995 SF 300 LF/day = 7 days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Common building laborers (2)	7	day	$889	=	**$6,226**
Materials	1,995	LF	$5	=	**$10,765**

Soils Excavation

Total excavation volume of soils

See Appendix C-3 for soil volume calculations and Figure 3-3 for excavation areas.

Soil volume 13,700 BCY

Secondary volume (5%) 685 BCY

Excavation Duration

Reference - RS Means 31 23 1642 0305 for 2017 in Queens, NY

Excavation production rate is limited by the transportation and disposal offsite rate. (Cost Item 9)

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration 13,700 BCY 188 CY/day = 74 days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	74	day	$467	=	$34,592
Laborers (2)	74	day	$889	=	$65,822
Equip. Oper. (medium)	74	day	$608	=	$45,016
Equip. Op. (heavy)	74	day	$633	=	$46,824
Hyd. Excavator (3.5 CY)	74	day	$2,401	=	$177,674
Dozer (80 HP)	74	day	$469	=	$34,676
Subtotal				=	**$404,605**

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY **74 days**

TOTAL COST FOR SOIL EXCAVATION **$562,508**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

07 - Post-excavation Sampling

Post-excavation sampling

Samples will be collected from excavation sidewalls and bottom.

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area
152	2	=	304
1900	2	=	3,800
558	4	=	2,232
156	4	=	624
85	4	=	340
335	2	=	670
100	4	=	400
100	4	=	400

Total surface area of excavation bottom	89,725	SF	See Appendix D
Total surface area of excavation sidewalls	8,770	SF	
Total surface area	98,495	SF	
Number of samples	110	samples	
Plus QC samples (10%)	121	samples	

Sampling costs based on remedial investigation.

Field ISOCS gamma spec unit with LabSOCS software	3	month	$6,000	=	$18,000
Gamma spec analytical cost	121	each	$75	=	$9,075
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	13	each	$200	=	$2,600
Subtotal				**=**	**$34,675**

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	13,700	BCY	17,125	LCY	*Loose factor of 1.25%*
Total samples	35	samples			

Sampling costs based on remedial investigation.

Radiological Analysis	35	samples	$75	=	$2,625
TCLP/TCL	4	samples	$1,200	=	$4,800
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	13	each	$200	=	$2,600
Subtotal				**=**	**$15,025**

TOTAL COST FOR POST-EXCAVATION SAMPLING	**$50,000**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Assume overlying soil above sewer pipe is clean and will be segregated, stockpiled, sampled, and used as backfill after replacement of the new sewer pipe.
Assume overlying soil is removed with excavator and soil on either side of the sewer pipe is hand dug.
Assume 2 feet of soil beneath sewer pipeline is contaminated and will be segregated for offsite disposal.
Assume sewer line removal occurs after building demolition and soils excavation; therefore, the WACC property will be used as staging.

Pipeline total (I-1 to I-4, C-1 to I-3)			Sewer line length
12" clay pipeline	150	feet	I-1 to I-4
24" pipeline	855	feet	I-4 to I-11
15" clay pipeline	200	feet	C-1 to I-3
Total length to be removed	1,210	feet	
Total length to be flushed (I-4 to W-1)			
15" clay pipeline	200	feet	C-1 to I-3
24" pipeline	986	feet	I-4 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be flushed	2,150	feet	
Total length to be relined (I-11 to W-1)			
24" pipeline	131	feet	I-11 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be relined (I-11 to W-1)	1,090	feet	

Assume depth of excavation is the depth of the end point pipeline manhole.

Pipeline Section	Length	Depth of Manhole (VLF)	Depth of Excavation (VLF)
C-1 to I-3	200	9.7	12
I-1 to I-2	80	10	12
I-2 to I-3	20	10	12
I-3 to I-4	50	13.8	16
I-4 to I-5	75	13.1	15
I-5 to I-6	130	14.5	17
I-6 to I-7	129	15.5	18
I-7 to I-8	130	17.5	20
I-8 to I-9	131	16.7	19
I-9 to I-10	130	16.3	18
I-10 to I-11	130	16	18

Number of manholes to be replaced

Manholes 11 manholes

	Depth of Manhole	
C-1	9.7	VLF
I-2	10	VLF
I-3	10	VLF
I-4	13.8	VLF
I-5	13.1	VLF
I-6	14.5	VLF
I-7	15.5	VLF
I-8	17.5	VLF
I-9	16.7	VLF
I-10	16.3	VLF
I-11	16	VLF
Total depth	153	VLF

Staging Area construction

Reference - RS Means 02 56 1310 0722 for 2017 in Queens, NY

Area of construction staging area			30,000 SF		
HDPE liner	30,000	SF	$1.83	=	$54,900

Perimeter requiring fencing 775 LF

Fencing installation duration

Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Duration	775 SF		300 LF/day		=	3	days
	Quantity	Unit	Unit Cost			Extended Cost	
Labor and Equipment							
Common building laborers (2)	3	day	$960		=	$2,880	
Materials	775	LF	$5		=	$3,875	
Subtotal					=	**$61,655**	

Sewer Flushing and Relining

Sewer will be flushed from I-1 to W-1 and C-1 to I-3.

Flushing Duration	2,150 LF		195 LF/day	=	12	days
Relining Duration	1,090 LF		90 LF/day	=	13	days
Pipe cleaning and inspection	12	day	$6,000	=	$72,000	
Relining	1,060	LF	$470	=	$498,200	
Reconnecting	100	each	$500	=	$50,000	
Subtotal					**$620,200**	

Road Removal

Assume width of road cut and excavation would be 8 feet for pipe diameters 12" - 24".

Assume 4-6" thick pavement.

Roadway to be removed		10,000 SF
	=	1,112 SY

Road removal

Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY

Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration - concrete removal	1,112 SY		200 SY/day	=	6	days
Duration - asphalt removal	1,112 SY		420 SY/day	=	3	days
	Quantity	Unit	Unit Cost		Extended Cost	
Labor						
Labor foreman	9	day	$467	=	$4,207.18	
Laborers (2)	9	day	$889	=	$8,005.39	
Equip. Oper. (light)	9	day	$579	=	$5,214	
Equip. Oper. (medium)	9	day	$608	=	$5,475	
Backhoe loader (48 HP)	9	day	$366	=	$3,296	
Hyd. Hammer (1200 lbs)	9	day	$182	=	$1,640	
Front end loader (4 CY)	9	day	$658	=	$5,918	
Pavement rem. bucket	9	day	$58	=	$520	
Subtotal				=	**$34,276**	

Soil Excavation and Sewer Pipe and Manhole Removal and Associated Sheeting

Volumes		
Non-contaminated soil above sewer line	4,317	BCY
Contaminated soil round and below sewer	704	BCY

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Excavation							
	Reference - RS Means 31 23 1613 1335 for 2017 in Queens, NY						
	Excavation production rate is reduced by 80% to account for hand digging around utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Exc. Duration	5,021 CY		230 CY/day	=	22	days
	Labor						
	Labor foreman	22	day	$467	=	$10,284	
	Laborers (2)	22	day	$889	=	$19,569	
	Equip. Oper. (medium)	22	day	$608	=	$13,383	
	Equip. Op. (heavy)	22	day	$633	=	$13,921	
	Hyd. Excavator (3.5 CY)	22	day	$2,401	=	$52,822	
	Dozer (80 HP)	22	day	$469	=	$10,309	
	Subtotal				**=**	**$120,288**	
Sewer pipe removal							
	Reference - RS Means 02 41 1323 2900 for 2017 in Queens, NY (pipe 12"diameter)						
	Reference - RS Means 02 41 1323 2930 for 2017 in Queens, NY (pipe 15"-18"diameter)						
	Reference - RS Means 02 41 1323 2960 for 2017 in Queens, NY (pipe 21"-24"diameter)						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration (12")	150 LF		35 LF/day	=	5	days
	Duration (15")	200 LF		30 LF/day	=	7	days
	Duration (24")	855 LF		24 LF/day	=	36	days
	Labor						
	Laborers (2)	48	day	$889	=	$42,695	
	Equip. Op. (heavy)	48	day	$633	=	$30,372	
	Hyd. Excavator (3.5 CY)	48	day	$2,401	=	$115,248	
	Subtotal				**=**	**$188,316**	
	Sewer bypass system	192	day	$5,000	=	**$960,000**	
Manhole removal							
	Reference - RS Means 02 41 1342 0100 for 2017 in Queens, NY						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration	153 VLF		2 VLF/day	=	96	days
	Labor						
	Laborers (2)	96	day	$889	=	$85,390.85	
	Equip. Op. (light)	96	day	$579	=	$55,618.56	
	Backhoe Loader	96	day	$366	=	$35,155.20	
	Subtotal				**=**	**$176,165**	

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	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Sheeting

It is assumed that due to utilities in the road and the depth of excavation, soldier piling and lagging walls would be required for sheeting.

Reference - RS Means 31 52 1610 0200 for 2017 in Queens, NY (for excavations 0-15 ft)
Reference - RS Means 31 52 1610 0500 for 2017 in Queens, NY (for excavations 15-22 ft)
Production rate is reduced by 40% to account for utilities.
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Sheeting Duration (production rate multipled by 2 for double crew)					92	days
Sheeting (0-15)	9,345 SF		594 SF/day	=	16	days
Sheeting (15-22)	29,792 SF		396 SF/day	=	76	days

Labor	Quantity	Unit	Unit Cost		Extended Cost
Sheeting system (daily costs multiplied by 2 to account for double crew)					
Pile driver foreman (2)	92	day	$2,340	=	$215,295
Pile drivers (6)	92	day	$6,748	=	$620,801
Equip. Oper. (heavy) (2)	92	day	$2,531	=	$232,853
Equip. Oper. (oiler)	92	day	$1,091	=	$100,332
Laborers (3)	92	day	$2,668	=	$245,499
Crawler Crane (40 ton)	92	day	$2,626	=	$241,592
Lead, 60' high	92	day	$152	=	$13,984
Hammer, diesel	92	day	$1,212	=	$111,467
Air compressor (600 cfm)	92	day	$964	=	$88,688
50' air hoses (2)	92	day	$60	=	$5,483
Chain saw, gas (36 inches)	92	day	$90	=	$8,280

Materials

Assume that materials can be reused as crew moves from block to block.

Assume 3 sections of trench (one section is from manhole to manhole at approximately 200 length feet) would require sheeting at one time.

Sheeting	24000	SF	$11	=	$270,000
Subtotal				=	**$2,154,273**

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Total surface area of excavation (sidewalls and bottom)	58,080	SF
Number of samples	65	samples
Plus QC samples (10%)	72	samples

Field ISOCS gamma spec unit with LabSOCS so	1	month	$6,000	=	$6,000
Gamma spec analytical cost	72	each	$75	=	$5,400
Shipping	5	each	$200	=	$1,000
Subtotal				=	**$12,400**

Waste characterization sampling

Assume one sample per 500 CY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	704	BCY	880	LCY	*Loose factor of 1.25*
Total samples		2	samples		

Sampling costs based on remedial investigation.

Radiological Analysis	2	samples	$75	=	$150
TCLP/TCL	1	samples	$1,200	=	$1,200
Shipping	5	each	$200	=	$1,000
Subtotal				=	**$2,350**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017		
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Sewer and Manhole Replacement and Restoration

Sewer pipeline replacement

Pipeline total to be replaced						
12" clay pipeline			150	feet		
15" clay pipeline			200	feet		
24" reinforced concrete pipeline			855	feet		
Duration						
Reference - RS Means 33 41 1360 2010 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2020 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2040 for 2017 in Queens, NY						
Production rate is reduced by 40% to account for utilities.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration -12"	150 LF		90 LF/day	=	2	days
Duration -15"	200 LF		90 LF/day	=	3	days
Duration -24"	855 LF		60 LF/day	=	15	days
Total Duration				=	20	days
Labor (for pipe diameters 12"-24")						
Labor foreman	20	day	$467	=	$9,349	
Laborers (4)	20	day	$1,779	=	$35,580	
Equip. Op. (light)	20	day	$579	=	$11,587	
Backhoe Loader (48 HP)	20	day	$366	=	$7,324	
Materials						
Pipeline 12"	150	LF	$17	=	$2,567	
Pipeline 24"	200	LF	$22	=	$4,416	
Pipeline 15"	855	LF	$31	=	$26,710	
Bedding material (6 inches)	4,840	LCY	$52	=	$251,680	
Subtotal				=	**$349,213**	

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Manhole Replacement							
	Duration						
	Reference - RS Means 33 49 1310 0600 for 2017 in Queens, NY (8' deep)						
	Reference - RS Means 33 49 1310 0700 for 2017 in Queens, NY (For depths over 8')						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Number of manholes to 8'	11	each				
	Extra depth	65	VLF				
	Duration for 8' VLF manhole	11 each		0.7 each/day	=	16	days
	Duration for extra depth	65 VLF		5.5 VLF/day	=	12	days
						28	days
	Labor and Materials						
	Manholes to 8'				=	$59,264	
	Extra depth				=	$51,245	
	Subtotal				**=**	**$110,508**	
Backfill							
	Excavated clean soils testing for backfill						
	Non-contaminated soil above sewer line		4,317	BCY			
	VOC samples	15	each	$75	=	$1,125	
	SVOCs	6	each	$145	=	$870	
	Inorganics	6	each	$85	=	$510	
	PCBs	6	each	$70	=	$420	
	Pesticides	6	each	$65	=	$390	
	Planning and sample collection	6	each	$200	=	$1,200	
	Sample reporting	1	LS	$5,000	=	$5,000	
	Subtotal				**=**	**$9,515**	
	Common fill needed	*Loose factor of 1.25%*					
	Contaminated soil round and below sewer		704	BCY	880	LCY	
	Common fill	1,126	tons	$26	=	**$29,286**	
	Duration						
	Reference - RS Means 31 23 1613 3080 for 2017 in Queens, NY						
	Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration (fill)	1,126 LCY		120 LCY/day	=	10	days
	Duration (compact)	9,640 SY		560 SY/day	=	18	days
	Labor						
	Laborers (2)	28	day	$889	=	$24,906	
	Equip. Oper. (medium)	28	day	$608	=	$17,033	
	Front end loader	28	day	$556	=	$15,574	
	Compaction Roller	28	day	$183	=	$5,118	
	Subtotal				**=**	**$62,631**	

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

08 - Sewer Line Excavation, Removal, and Replacement

Roadway restoration

Road to be replaced			10,000 SF			
			1,112 SY			
Duration						
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY						
Reference - RS Means 32 12 1613 0200 in Queens, NY						
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY						
Production rate is reduced by 80% to account for tight areas.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration - concrete	1,112 SY		600 SY/day	=	2	days
Duration - binder	1,112 SY		828 SY/day	=	2	days
Duration - wearing	1,112 SY		900 SY/day	=	2	days
Labor						
Labor foreman	6	day	$467	=	$2,805	
Laborers (7)	6	day	$3,113	=	$18,679	
Equip. Oper. (medium) (3)	6	day	$1,825	=	$10,950	
Rodman	2	day	$618	=	$1,235	
Cement finisher	2	day	$533	=	$1,065	
Grader	2	day	$966	=	$1,931	
Paving machine	2	day	$2,455	=	$4,910	
Asphalt paver	4	day	$2,235	=	$8,940	
Tandem roller	4	day	$238	=	$950	
Pneumatic wheel roller	4	day	$356	=	$1,423	
Materials						
Concrete (6")	1,112	SY	$41	=	$45,792	
Binder Course (4")	1,112	SY	$23	=	$25,817	
Wearing Course (3")	1,112	SY	$19	=	$21,238	
Subtotal				=	**$145,737**	

Duration of sewer line excavation, removal, and replacement is based on sheeting, pipe replacement, and manhole replacement due to concurrency of other tasks.

TOTAL DURATION OF ACTIVITY	**140 days**
TOTAL COST FOR SEWER LINE EXCAVATION, REMOVAL, AND REPLACEMENT	**$5,037,000**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

09 - Other Impacted Buildings Excavation

Assume an area of 25 feet by 27 feet with a depth of 4 feet of soils exceed PRGs and needs to be removed from below a concrete slab.
Assume low overhead clearance.

Foundation Removal

Assume foundation is slab-on-grade has a depth of 6 inches and is rod reinforced.

Total volume of foundation to remove	675 SF	13 CY	
	0.5 feet		

Removal Duration

Reference - RS Means 02 41 1916 0020 for 2017 in Queens, NY
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	675 SF	175 SF/day	=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (4)	4	day	$1,779	=	$7,116
Air compressor	4	day	$181	=	$725
Pavement breaker (2)	4	day	$20	=	$82
50' air hoses (2)	4	day	$12	=	$46
Subtotal				=	**$9,839**

Soils Excavation

Total excavation volume of soils

Soil volume	100 BCY

Excavation Duration

Reference - RS Means 31 23 1616 0200 for 2017 in Queens, NY
Production rate is reduced by 20% to account for unknown conditions associated with data gaps for potentially impacted properties.
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	100 BCY	19 CY/day	=	6	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	6	day	$467	=	$2,805
Laborers (4)	6	day	$1,779	=	$10,674
Subtotal				=	**$13,479**

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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

09 - Other Impacted Buildings Excavation

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area			
104	4	=	416			
Total surface area of excavation sidewalls		416	SF			
Total surface area of excavation bottom		675	SF			
Number of samples		2	samples			
Plus QC samples (10%)		3	samples			
Sampling costs based on remedial investigation.						
Field ISOCS gamma spec unit with LabSOCS software	1	week	$2,000	=	$2,000	
Gamma spec analytical cost	3	each	$75	=	$225	
Shipping	1	each	$200	=	$200	
Subtotal				=	**$2,425**	

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	100	BCY	125	LCY	
Total samples		1	samples		
Sampling costs based on remedial investigation.					
Radiological Analysis	1	samples	$75	=	$75
TCLP/TCL	1	samples	$1,200	=	$1,200
Shipping	1	each	$200	=	$200
Subtotal				=	**$1,475**

Backfill

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Common fill needed		100	BCY	125	LCY	
	=	160 tons				
Duration						
Reference - RS Means 31 23 2313 0400 for 2017 in Queens, NY						
Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration (fill)	125 LCY	100 CY/day		=	2	days
Duration (compa	75 SY	2800 SY/day		=	1	days
Labor and Equipment						
Laborers (2)	3	day	$889	=	$2,668	
Equip. Oper. (medium)	3	day	$608	=	$1,825	
Compaction Roller	3	day	$183	=	$548	

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
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09 - Other Impacted Buildings Excavation

Materials						
Common fill cost includes materials and trucking to site.						
Common fill	160	ton	$26	=	$4,160	
Subtotal				**=**	**$9,202**	

Concrete replacement

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Concrete		13	CY			
Duration						
Reference - RS Means 03 30 5340 4000 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration	13 CY		39 CY/day	=	1	days
Labor and Equipment						
Labor foreman	1	day	$467	=	$467	
Laborers (4)	1	day	$1,779	=	$1,779	
Carpenters (6)	1	day	$3,357	=	$3,357	
Rodmen (2)	1	day	$1,234	=	$1,234	
Cement finisher	1	day	$532	=	$532	
Gas engine vibrator	1	day	$28	=	$28	
Subtotal				**=**	**$7,397**	

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**6 days**
TOTAL COST FOR OTHER IMPACTED BUILDINGS EXCAVATION	**$44,000**

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10a - Transportation and Disposal

Construction material calculations presented in Appendix A.
Estimates are budgetary, include transportation to the disposal facility and disposal fee, and were given by I.C.E. Service Group for the year 2019.
Quantity calculation based on existing data.
Assume 0% bulking factor for construction materials (building and sewer).
Assumes 1.9 tons per CY of construction materials.
Assumes 1.6 tons per CY of soils.
Assumes debris to be less than 3'x3'x3'.
Assumes non-radiologically contaminated material/non-hazardous material would be transported to Pennsylvania (IESI/Progressive Waste Solutions).
Assumes radiologically-contaminated material would be transported to Idaho (US Ecology).
Assume radiologically-contaminated material mixed with TSCA waste would go to Texas (Waste Control Specialists).

Type	Quantity	Unit Cost	Extended Cost
Non-radiologically contaminated material	*tons*		
Lot 33 non-radiologically-contaminated building materials	615	$100	$61,500
Sewer - pavement debris	400	$100	$40,000
Radiologically contaminated material	*tons*		
Lot 33 radiologically-contaminated building materials	440	$435	$191,400
Pavement debris	1,300	$435	$565,500
Primary Excavation Soils	22,000	$435	$9,570,000
Secondary Excavation Soils	1,100	$435	$478,500
TSCA+Rad Soils	80	$700	$56,000
Sewer - Construction materials	80	$435	$34,800
Sewer - Soils	1,300	$435	$565,500
Decontamination water	*drums*		
Aqueous	1,200	$295	$354,000
Total	**27,315**		**$11,917,200**

TOTAL COST FOR TRANSPORTATION AND DISPOSAL	**$11,918,000**

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

10b - Transportation and Disposal Associated Labor

Assume offsite loading would be performed concurrently to demolition, excavation, and sewer line activities.

Assume 15 trucks could depart the site on a daily basis with a load of 20 tons.

Duration of disposal for demolition						
1,055 tons			300 tons/day	=	4	days
Duration of disposal for excavation						
24,480 tons			300 tons/day	=	82	days
Duration of disposal for sewer materials						
1,780 tons			300 tons/day	=	6	days
Labor and Equipment (during demolition)						
Laborers (2)	4	day	$889	=	$3,558	
Traffic controllers (2)	4	day	$960	=	$3,840	
Equip. Op. (heavy)	4	day	$633	=	$2,531	
Hyd. Excavator (3.5 CY)	4	day	$2,401	=	$9,604	
Subtotal				**=**	**$19,533**	
Labor and Equipment (during excavation)						
Because production rate of excavation is limited by the number of trucks that can be loaded each day on the site,						
it is assumed that equipment used for the excavation can also be used for loading.						
Labor and Equipment (during sewer line)						
Laborers (2)	6	day	$889	=	$5,337	
Traffic controllers (2)	6	day	$960	=	$5,760	
Equip. Op. (heavy)	6	day	$633	=	$3,797	
Hyd. Excavator (3.5 CY)	6	day	$2,401	=	$14,406	
Subtotal				**=**	**$29,299**	
TOTAL COST FOR TRANSPORTATION AND DISPOSAL LABOR ONLY					**$49,000**	

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

11 - Site Restoration

Backfill

Assume backfill will consist of common fill.

Assume backfill rate of 975 LCY per day.

					Loose factor of 25%		
Common fill needed			13,700 BCY		17,125 LCY		
	=		21,920 tons				
Duration							
Reference - RS Means 31 23 2314 2020 for 2017 in Queens, NY							
Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration (fill)	17,125 LCY		975 LCY/day		=	18	days
Duration (compact)	9,790 SY		2800 SY/day		=	4	days
Labor							
Laborers (2)		22	day	$889	=	$19,569	
Equip. Oper. (medium)		22	day	$608	=	$13,383	
Dozer (200 HP)		22	day	$556	=	$12,236	
Compaction Roller		22	day	$183	=	$4,022	
Materials							
Common fill cost includes materials and trucking to site.							
Common fill		21,920	ton	$26	=	$569,920	
Geotextile liner		9,790	SY	$2.50	=	$24,475	
Subtotal					=	**$643,605**	

Road/Asphalt Replacement

Road to be replaced			39,423 SF				
			4,390 SY				
Duration							
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0200 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration - concrete	4,390 SY		3,000 SY/day		=	2	days
Duration - binder	4,390 SY		4,140 SY/day		=	2	days
Duration - wearing	4,390 SY		4,500 SY/day		=	1	days
Labor							
Labor foreman		5	day	$467	=	$2,337	
Laborers (7)		5	day	$3,113	=	$15,566	
Equip. Oper. (medium) (3)		5	day	$1,825	=	$9,125	
Rodman		2	day	$618	=	$1,235	
Cement finisher		2	day	$533	=	$1,065	
Grader		2	day	$966	=	$1,931	
Paving machine		2	day	$2,455	=	$4,910	
Asphalt paver		3	day	$2,235	=	$6,705	
Tandem roller		3	day	$238	=	$713	
Pneumatic wheel roller		3	day	$356	=	$1,067	

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CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

11 - Site Restoration

Materials							
Binder Course		4,390	SY	$23	=	$101,923	
Wearing Course		4,390	SY	$19	=	$83,845	
Subtotal					=	**$230,422**	

Sidewalk Replacement

Assume a 6-inch sidewalk will be installed.

Total area of sidewalk to install			7,819 SF				
Duration							
Reference - RS Means 32 06 1010 0310 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	7,819 SF		1,200 SF/day		=	7	days
Labor							
Laborers (2)		7	day	$889	=	$6,226	
Cement Finisher(2)		7	day	$1,063	=	$7,443	
Carpenter (2)		7	day	$1,119	=	$7,833	
Subtotal					=	**$21,502**	
Materials							
Concrete, 4" thick		7,819	SF	$3	=	$25,648	
Subtotal					=	**$25,648**	

Gravel Placement

Assume 6 inches of gravel will be placed on the property.

Gravel needed			31,330 SF		581 SY		
Duration							
Assume production rate of 5000 SY per day							
Duration	581 SY		5,000 SY/day		=	1	days
Labor							
Labor foreman		7	day	$467	=	$3,272	
Laborers (2)		7	day	$889	=	$6,226	
Equip. Oper. (medium) (2)		7	day	$1,217	=	$8,517	
Grader		7	day	$750	=	$5,250	
Dozer		7	day	$469	=	$3,280	
Vibratory roller		7	day	$183	=	$1,280	
Subtotal					=	**$27,825**	
Materials							
Gravel, 6" thick		581	SY	$4	=	$2,324	
Subtotal					=	**$2,324**	

Fencing to secure property

Perimeter requiring fencing		400	LF				
Fencing installation duration							
Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	400 SF		300 LF/day		=	2	days

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JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017	
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Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

11 - Site Restoration

	Quantity	Unit	Unit Cost		Extended Cost	
Labor and Equipment						
Common building laborers (2)	2	day	$889	=	**$1,779**	
Materials	400	LF	$5	=	**$2,000**	

Final Status Survey

Assume gross gamma measurements and exposure rate measurements will be collected.

Based on previous work completed at the site.

Surface area (includes soil and sewer excavation)		58,080 SF				
Gamma exposure rate measurements		8				
Duration						
Assume production rate of 12000 SF per day						
Duration - scan survey	58,080 SF	12,000 SF/day		=	5	days
Duration - exposure rate	8 each	2 each/day		=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor					
Labor and equipment are accounted for in general requirements					
NaI detector	2	week	$160	=	$320
Borehole probes	2	week	$150	=	$300
GPS	9	day	$640	=	$5,760
Final Status Survey Plan	1	LS	$25,000	=	$25,000
Final Status Survey Report	1	LS	$25,000	=	$25,000
Subtotal				**=**	**$56,380**

Duration of restoration is based on duration of backfill, sidewalk placement, and the final status survey due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**38 days**
TOTAL COST FOR SITE RESTORATION	**$1,012,000**

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	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

12 - Radon Mitigation System Maintenance, Radon Monitoring, and Groundwater Monitoring

Assume maintenance and monitoring for radon mitigation system installed at Lot 42 (TerraNova) will continue for 30 years.

Inspection and Maintenance

Assume 3% of backfill costs for maintenance every year for a default period of 30 years.

Annual allowance for inspection and annual report	1	LS	$7,500	=		$7,500
Soil cover maintenance	1	LS	$26,221	=		$26,221
Subtotal				=		**$33,721**

Annual radon mitigation system maintenance

Monthly inspection	96	Hr	$95	=		$9,120
Semi-annual preventative maintenance	40	Hr	$100	=		$4,000
Expenses (upkeep and maintenance)	1	LS	$5,000	=		$5,000
Reporting (month and year)	1	LS	$15,000	=		$15,000
Subtotal				=		**$33,120**

Radon monitoring

Yearly number of air samples	10					
Sampling Project Planning						
Project manager	8	hour	$150	=	$	1,200
Engineer	8	hour	$110	=	$	880
Scientist	8	hour	$100	=	$	800
Procurement	5	hour	$90	=	$	450
Field Sampling						
Mob/demob	16	hour	$110	=	$	1,760
Sampling	24	hour	$110	=	$	2,640
Equipment & PPE	1	each	$200	=	$	200
Shipping	2	days	$75	=	$	150
Sampling Analysis (includes QC samples)						
Radon/Thoron	11	samples	$150	=	$	1,650
Reporting						
Project manager	8	hour	$150	=	$	1,200
Scientist	24	hour	$100	=	$	2,400
QA/QC	4	hour	$110	=	$	440
Data validation	4	hr	$150	=	$	600
Tabulate the data and prepare figures	1	LS	$3,000	=	$	3,000
Prepare the data report	1	LS	$5,000	=	$	5,000
Clerk	8	hour	$75	=	$	600
Subtotal				=		**$22,970**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017		DATE CHECKED: 7/14/2017	
	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 2 - Individual Cost Item Backup

12 - Radon Mitigation System Maintenance, Radon Monitoring, and Groundwater Monitoring

Groundwater monitoring

Number of monitoring wells	6	wells				
Number of samplers	2	samplers				
Number of 8 hour workdays	1	day				
Sampling Project Planning						
Project Manager	4	hr	$150	=	$	600
Engineer	8	hr	$110	=	$	880
Scientist	8	hr	$100	=	$	800
Procurement	5	hour	$90	=	$	450
Field Sampling						
Field Tech 1	8	hour	$85	=	$	680
Geologist	8	hour	$110	=	$	880
Per diem	1	day	$181	=	$	181
Car rental	2	day	$95	=	$	190
Equipment & PPE	1	LS	$200	=	$	200
Shipping	1	day	$75	=	$	75
Misc	1	day	$100	=	$	100
Sampling Analysis (includes QC samples)						
Gamma spectroscopy	7	ea	$100	=	$	700
Reporting						
Project manager	8	hour	$150	=	$	1,200
Scientist	24	hour	$100	=	$	2,400
QA/QC	4	hour	$110	=	$	440
Data validation	3.5	hr	$150	=	$	525
Tabulate the data and prepare figures	1	LS	$3,000	=	$	3,000
Prepare the data report	1	LS	$5,000	=	$	5,000
Clerk	8	hour	$75	=	$	600
Subtotal				=	**$18,901**	

TOTAL ANNUAL COST FOR MITIGATION SYSTEM MAINTENANCE, RADON/GW MONITORING, COVER O&M **$109,000**

Present Worth Calculation for Inspection and Maintenance Costs

This is a recurring cost every year.
This discount factor is (P/A,i,n)
P = Present Worth
A = Annual amount
i = interest rate 7%
n = number of years 30

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

The multiplier for (P/A) = **12.4**

TOTAL INSPECTION, MAINTENANCE, and MONITORING COST: **$1,353,000**

Appendix F-2
Cost Estimate for Alternative 3
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

No.	Description	Cost
	Remedial Action	
01	Permanent relocation	$625,000
02	General requirements	$3,473,000
03	Site preparation/site work	$377,000
04	Demolition and segregation	$223,000
05	Excavation and segregation	$665,603
06	Post-excavation sampling	$61,000
07	Sewer line excavation, removal, and replacement	$5,037,000
08	Other impacted buildings excavation and restoration	$44,000
09a	Transportation and disposal costs	$13,487,000
09b	Transportation and disposal labor	$108,000
10	Restoration and Final Status Survey	$1,230,000
	Subtotal for Construction Activities	*$11,219,000*
	Subtotal for Transportation and Disposal	*$13,487,000*
	Contingency on Construction Activities (20%)	$2,244,000
	Contingency on Transportation and Disposal (20%)	$2,698,000
	Subtotal for Construction Activities	*$13,463,000*
	Subtotal for Transportation and Disposal	*$16,185,000*
	General Contractor Bond and Insurance - Construction Activities (5%)	$674,000
	General Contractor Bond and Insurance - Transportation and Disposal (5%)	$810,000
	Subtotal for Construction Activities	*$14,137,000*
	Subtotal for Transportation and Disposal	*$16,995,000*
	General Contractor Markup - Construction Activities (10%)	$1,414,000
	General Contractor Markup - Transportation and Disposal (2%)	$340,000
	Subtotal of Remedial Action Construction Activities	$15,551,000
	Subtotal of Remedial Action Transportation and Disposal	$17,335,000
	Subtotal of Relocation	$625,000
11	**OPERATION AND MAINTENANCE COSTS**	
	Annual Inspection and Maintenance for Radon Mitigation System, Radon Monitoring, and Groundwater Monitoring	$60,000
	Present Worth for Inspection and Maintenance (30 Years)	$745,000
	PRESENT WORTH	
	Total Capital Cost (including relocation)	**$33,511,000**
	Total O&M Cost	**$745,000**
	Total Present Worth	**$34,256,000**

Note: The project cost presented herein represents only feasibility study level, and is thus, subject to change pending the results of the pre-design investigation, which is intended to collect sufficient data to assist in the development of remedial design and associated detailed cost estimate. Expected accurant range of the cost estimate is -30% to +50% ($23,979,200 to $51,384,000).
The estimate is prepared solely to facilitate relative comparisons between feasibility study alternatives for evaluation.
The costs do not include costs for project management and construction management, remedial design, pre-design investigation, or relocation.
Reference: EPA. A Guide to Developing Cost Estimates During the Feasibility Study. 540-R-00-002. July 2000.

CDM Smith

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

01 - Permanent Relocation

Block	Lot	Owner	Tenant	Address
3725	33	Unique Development	Empty warehouse, no tenant	11-33 Irving Avenue
	42	LPL Properties, Inc.	Primo Auto Body and TerraNova	11-29 Irving Avenue
	44	LPL Properties, Inc.	Celtic Bike Shop	11-27 Irving Avenue
	46	Second A-One	Jarabacoa Deli	11-25 Irving Avenue
	48	Rudy Reyes	K&M Auto Repair	15-14 Cooper Avenue

Permanent Relocation for Tenants of Lot 42, 44, 46, and 48

Costs are estimated following 49 CFR 24 - Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs.
Costs are estimated based on relocation costs incurred at another Ragion 2 Superfund Site in the tri-state area.
Estimate for incremental rent is based on an increase of $500 in rent per month for 42 months.

	Quantity	Unit	Unit Cost		Extended Cost
Reestablishment Costs	5	each	$25,000	=	$125,000
Search expenses	5	each	$2,500	=	$12,500
Related expenses	5	each	$25,000	=	$125,000
Incremental rent for 42 months	5	each	$21,000	=	$105,000
Moving expenses	5	each	$40,000	=	$200,000
				Subtotal	**$567,500**
Admininistration costs	1	LS	$56,750	=	**$56,750**
TOTAL COST FOR PERMANENT RELOCATION					**$625,000**

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Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

02 - General Requirements

Project Schedule

Assume the following construction schedule.

Pre-construction work plans and meetings	3 months	13 weeks
Construction Period		
Field mobilization and site preparation	1 months	5 weeks
Building demolition	2 months	9 weeks
Soil excavation (including roadway)	4 months	18 weeks
Sewer line excavation, removal, and replacement	5 months	22 weeks
Site restoration and demobilization	2 months	9 weeks
Total construction duration	*14 months*	*61 weeks*
Total project duration in months	**17 months**	
Total project duration in weeks	**74 weeks**	

General Conditions

A) Project Management and Site Supervisory

Assume the following staff for the duration of project with Project Manager at 16 hours/week, Project Engineer at 20 hours/week, and procurement staff at 10 hours/week.

	Quantity	Unit	Unit Cost		Extended Cost
Project Manager	1,184	hr	$150	=	$177,600
Project Engineer	1,480	hr	$110	=	$162,800
Procurement staff	740	hr	$90	=	$66,600
Scheduler	136	hr	$100	=	$13,600
Total management and office support					$420,600

B) Work Plan Preparation

Estimated # of Pre-Construction Work Plans Required:	15 work plans
Estimated # of Engineer Hours Required per Work Plan:	60 hours each
Estimated # of Project Manager Hours Required per Work Plan:	2 hours each

Project Engineer	900	hr	$110	=	$99,000
Project Manager (half time)	15	hr	$150	=	$2,250
Total Work Plan Preparation Cost					$101,250

C) Remedial Action Report

Project Engineer	400	hr	$110	=	$44,000
Project Manager	60	hr	$150	=	$9,000
Total Remedial Action Report Preparation Cost					$53,000

D) Permits

Permit Specialist	250	hr	$125	=	$31,250
Project Manager	120	hr	$150	=	$18,000
Total Permitting Cost					$49,250

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

02 - General Requirements

E) Onsite supervisory

Assume the following full time site supervisory staff for the duration of construction.

Assume 40 hours per week.

Assume construction foreman would be local and not require a truck.

Site Superintendent	2,440	hr	$150	=	$366,000
Construction Foreman	2,440	hr	$100	=	$244,000
Onsite QC Engineer	2,440	hr	$110	=	$268,400
Scheduler	2,440	hr	$100	=	$244,000
Pickup Truck #1	305	day	$100	=	$30,500
Pickup Truck #2	305	day	$100	=	$30,500
Total Onsite Supervisory Staff for Total Construction Duration (61 weeks)					$1,183,400
Subtotal General Conditions:					**$1,808,000**

Safety and Health Requirements

Safety and Health Requirements to include the Site Health and Safety Officer (SHSO)/Medium level health physicist, personnel protective equipment and supplies, and additional safety and air monitoring equipment/testing.

Assume PPE required for 20 people per work day for the duration of construction activities.

The radiological services cost are used from the remedial investigation bid sheet accounting for 3% escalation.

Assume senior health physicist time at 8 hours per month.

Assume a crew of 20 would be onsite.

SHSO/Med. Health Physicist	2440	hr	$62	=	$150,304
Junior Technician	2440	hr	$50	=	$122,976
Senior Health Physicist	112	hr	$112	=	$12,544
Equipment					
SKC PCXR4 lapel sampling pumps	14	month	$720	=	$10,080
Bios Defender calibrator	14	month	$200	=	$2,800
Ludlum 2929/43-10-1 alpha/beta sample counter	14	month	$480	=	$6,720
Ludlum 2360/43-93 alpha beta field meters	14	month	$720	=	$10,080
Ludlum model 2221/44-9 alpha/beta/gamma probe	14	month	$225	=	$3,150
Ludlum Model 9P pressurized ion chamber survey met	14	month	$200	=	$2,800
Work area air monitor	14	month	$165	=	$2,310
perimeter radiological air	14	month	$2,500	=	$35,000
Dust monitors	14	month	$1,450	=	$20,300
Filter media, smear	14	month	$50	=	$700
Radiation Badges	1360	each	$39	=	$53,312
PPE	305	day	$140	=	$854,000
Additional Safety and Air Monitoring Equipment			10%	=	$85,400
					$1,372,476

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017		
	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

02 - General Requirements

Temporary Facilities

Temporary Facilities to include the field trailers, utilities, cleaning services, and office equipment and supplies.

Assume four project trailers required (2 for Contractor, 1 for EPA, and 1 shower trailer)

Reference - RS Means 01 52 20 Construction Facilities for 2017 in Queens, NY.

Work space rental	14	month	$2,000	=	$28,000
Electricity	14	month	$177	=	$2,478
Electricity hookup	1	LS	$10,000	=	$10,000
Phone/Internet	14	month	$95	=	$1,330
Water/Sewer	14	month	$60	=	$840
Cleaning service and others	14	month	$300	=	$4,200
					$46,848

Security

Assume for duration of construction requires 16-hour security guard for weekdays and 24-hour security guard for weekends for the entire field duration.

Security trailer rental	14	month	$200	=	$2,800
Security guard	8,064	hours	$30	=	$241,920
					$244,720

TOTAL COST FOR GENERAL REQUIREMENTS	**$3,473,000**

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

03 - Site Work

Assume cars and mechanic-related materials will be removed from the property as part of relocation.
Assume staging area for demolition will be in the former rail spur area.
Assume excavation will be completed in phases to account for the limited site area.

Clearing and Grubbing

Assume clearing in the former rail spur area.
Assume staging area will be in the former rail spur area.
Reference - RS Means 31 11 1010 0010 Clear and Grub Site for 2017 in Queens, NY.

	Quantity	Unit	Unit Cost		Extended Cost
Clearing and grubbing	22,000	SF	$0.10	=	$2,200

Mobilization of Construction Equipment

Field mobilization (allowance)	1	LS	$75,000	=	$75,000

Surveying

Survey would be conducted duration excavation and sewer line removal.

Surveyor onsite during sewer removal and excavation period (for depth verification, quantity measurement, waste char. samples).
Assume surveyor time at 10 hours per week.

Total Surveying Duration 40 weeks

	Quantity	Unit	Unit Cost		Extended Cost
Professional Surveyor	40	hr	$120	=	$4,800
Surveyor	400	hr	$75	=	$30,000
Assistant Surveyor	400	hr	$65	=	$26,000
Submittals	1	LS	$20,000	=	$20,000
					$80,800

Erosion Control

Assume daily output of silt fencing at 1,300 LF and hay bales at 2,500 LF.
Reference - RS Means 31 25 1416 1000 for 2017 in Queens, NY
Reference - RS Means 31 25 1416 1250 Clear and Grub Site for 2017 in Queens, NY

Total excavation and backfill duration 49 weeks
Length of erosion control measure 1500 LF

	Quantity	Unit	Unit Cost		Extended Cost
Silt fence	1500	LF	$2.44	=	$3,660
Hay bale	1500	LF	$7.15	=	$10,725
Maintenance (10%)	49	week	$366.00	=	$17,934
					$32,319

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

03 - Site Work

Decontamination

Assume decontamination pad required during construction.

Assume decontamination water will be used for dust suppression.

	Quantity	Unit	Unit Cost		Extended Cost
Duration of construction			49 weeks		
Construction of decontamination pad					
	1	LS	$10,000	=	$10,000
Decontamination operation					
Assume 2 workers for 2 hours per day to perform equipment decontamination on-site including T&D trucks.					
Laborers (2)	490	day	$120	=	$58,800
Assume 15 trucks per day at 20 gallons per truck of steam cleaning.					
Assume 55-gallon drums filled to 50 gallons.					
Decon water produced	300	gals/day	73,500	gallons	
Drums	1,470	drum	$80	=	$117,600
Subtotal					$186,400
TOTAL COST FOR SITE WORK					**$377,000**

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

04 - Building Demolition and Construction Debris Disposal

Building is a mixture of steel, concrete, and masonry.
Assume building foundation is 6-inch concrete with reinforced rods.
Assume building demolition rate of 20100 CF per day.
Assume foundation demolition rate of 4000 CF per day.

Building Demolition - All buildings

Standing building volume - Lot 33		
Building footprint	12,375	SF
Building height	14	LF
Volume of building	173,250	CF
Standing building volume - Lot 42 and 44		
Buildings footprint	13,175	SF
Building height	14	LF
Volume of building	184,450	CF
Standing building volume - Lot 46		
Building footprint	5,000	SF
Building height	26	LF
Volume of building	130,000	CF
Standing building volume - Lot 48		
Building footprint	1,145	SF
Building height	13	LF
Volume of building	14,885	CF

Assume 6-inch concrete, reinforced rods foundation.

Building foundation volume - Lot 33		
Building footprint	12,375	SF
Foundation thickness	0.5	feet
Volume of building	6,188	CF
Building foundation volume - Lot 42 and 44		
Building footprint	13,175	SF
Foundation thickness	0.5	feet
Volume of building	6,588	CF
Building foundation volume - Lot 46		
Building footprint	5,000	SF
Foundation thickness	0.5	feet
Volume of building	2,500	CF
Building foundation volume - Lot 48		
Building footprint	1,145	SF
Foundation thickness	0.5	feet
Volume of building	573	CF

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

04 - Building Demolition and Construction Debris Disposal

Asbestos and Lead Paint Abatement

An initial hazardous building materials survey was completed for the site and found asbestos and lead at volume typical of a building at this age.

Asbestos Abatement		1	LS	$20,000	=	$20,000
Lead paint abatement		1	LS	$15,000	=	$15,000

Demolition of standing building

Reference - RS Means 02 41 1613 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	502,585 CF		20,100 CF/day		=	26	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	26	day	$467	=	$12,154
Laborers (2)	26	day	$889	=	$23,127
Equip. Oper. (medium) (2)	26	day	$1,217	=	$31,633
Equip. Oper. (oiler)	26	day	$545	=	$14,177
Hyd. Excavator (3.5 CY)	26	day	$2,401	=	$62,426
Hydraulic Crane (25 ton)	26	day	$674	=	$17,519

Demolition of foundation including slab

Assume footings would be removed as part of the excavation.

Reference - RS Means 02 41 1617 0400 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	31,695 SF	4,000 SF/day	=	8	days

Labor and Equipment					
Equip. Oper. (heavy) (2)	8	day	$1,266	=	$10,124
Hyd. Excavator, 1.5 CY	8	day	$965	=	$7,720
Hyd. Hammer (5,000 lbs)	8	day	$376	=	$3,010
Hyd. Excavator, 0.75 CY	8	day	$674	=	$5,394

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY **34 days**

TOTAL COST FOR BUILDING DEMOLITION **$223,000**

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

05 - Soils Excavation

Road Removal

Assume road has 4 inch depth.
See Figure 3-3 for areas of road to remove.

Total volume of roadway to remove		39,423 SF				
		4,390 SY				
Removal Duration						
Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY						
Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration - conc	4,390 SY	200 SY/day		=	22	days
Duration - asph	4,390 SY	420 SY/day		=	11	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	33	day	$467	=	$15,426
Laborers (2)	33	day	$889	=	$29,353
Equip. Oper (light)	33	day	$579	=	$19,119
Equip. Oper. (medium)	33	day	$608	=	$20,075
Backhoe loader (48 HP)	33	day	$366	=	$12,085
Hyd. Hammer (5,000 lbs)	33	day	$182	=	$6,013
Front end loader (4 CY)	33	day	$658	=	$21,701
Pavement rem. bucket	33	day	$58	=	$1,907
Subtotal				**=**	**$125,679**

Sidewalk Removal

Assume sidewalk has 6 inch depth.
See Figure 3-3 for areas of sidewalk to remove.

Total volume of sidewalk to remove		7,819 SF				
		870 SY				
Removal Duration						
Reference - RS Means 02 41 1317 5200 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration	870 SY	255 SY/day		=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (2)	4	day	$889	=	$3,558
Equip. Oper (light)	4	day	$579	=	$2,317
Equip. Oper. (medium)	4	day	$608	=	$2,433
Backhoe loader (48 HP)	4	day	$366	=	$1,465
Hyd. Hammer (1200 lbs)	4	day	$182	=	$729
Front end loader (4 CY)	4	day	$658	=	$2,630
Pavement rem. bucket	4	day	$58	=	$231
Subtotal				**=**	**$15,234**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017		
	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

05 - Soils Excavation

Fencing to secure excavation

Perimeter requiring fencing 1,995 LF

Fencing installation duration

Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration 1,995 SF 300 LF/day = 7 days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Common building laborers (2)	7	day	$889	=	**$6,226.42**
Materials	1,995	LF	$5	=	**$9,975**

Soils Excavation

Total excavation volume of soils

See Appendix C-3 for soil volume calculations and Figure 3-4 for excavation areas.

Soil volume 17,300 BCY

Secondary volume (5%) 865 BCY

Excavation Duration

Reference - RS Means 31 23 1642 0305 for 2017 in Queens, NY

Excavation production rate is limited by the transportation and disposal offsite rate. (Cost Item 9)

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration 17,300 BCY 188 CY/day = 93 days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	93	day	$467	=	$43,474
Laborers (2)	93	day	$889	=	$82,722
Equip. Oper. (medium)	93	day	$608	=	$56,575
Equip. Op. (heavy)	93	day	$633	=	$58,846
Hyd. Excavator (3.5 CY)	93	day	$2,401	=	$223,293
Dozer (80 HP)	93	day	$469	=	$43,580
Subtotal				=	**$508,490**

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY **93 days**

TOTAL COST FOR SOIL EXCAVATION **$665,603**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

06 - Post-excavation Sampling

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area
152	2	=	304
1564	2	=	3,128
558	4	=	2,232
156	4	=	624
85	4	=	340
335	2	=	670
100	4	=	400
100	4	=	400

Total surface area of excavation bottom	102,025	SF	See Appendix D
Total surface area of excavation sidewalls	8,098	SF	
Total surface area	110,123	SF	
Number of samples	123	samples	
Plus QC samples (10%)	136	samples	

Sampling costs based on remedial investigation.

Field ISOCS gamma spec unit with LabSOCS software	4	month	$6,000	=	$24,000
Gamma spec analytical cost	136	each	$75	=	$10,200
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	18	each	$200	=	$3,600
Subtotal				**=**	**$42,800**

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	17,300	BCY	21,625	LCY
Total samples	44	samples		

Sampling costs based on remedial investigation.

Radiological Analysis	44	samples	$75	=	$3,300
TCLP/TCL	5	samples	$1,200	=	$6,000
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	18	each	$200	=	$3,600
Subtotal				**=**	**$17,900**

TOTAL COST FOR POST-EXCAVATION SAMPLING **$61,000**

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Assume overlying soil above sewer pipe is clean and will be segregated, stockpiled, sampled, and used as backfill after replacement of the new sewer pipe.
Assume overlying soil is removed with excavator and soil on either side of the sewer pipe is hand dug.
Assume 2 feet of soil beneath sewer pipeline is contaminated and will be segregated for offsite disposal.
Assume sewer line removal occurs after building demolition and soils excavation; therefore, the WACC property will be used as staging.

Pipeline total (I-1 to I-4, C-1 to I-3)			Sewer line length
12" clay pipeline	150	feet	I-1 to I-4
24" pipeline	855	feet	I-4 to I-11
15" clay pipeline	200	feet	C-1 to I-3
Total length	1,210	feet	

Total length to be flushed (I-4 to W-1)			
15" clay pipeline	200	feet	C-1 to I-3
24" pipeline	986	feet	I-4 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be flushed	2,150	feet	

Total length to be relined (I-11 to W-1)			
24" pipeline	131	feet	I-11 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be relined (I-11 to W-1)	1,090	feet	

Assume depth of excavation is the depth of the end point pipeline manhole.

Pipeline Section	Length	Depth of Manhole (VLF)	Depth of Excavation (VLF)
C-1 to I-3	200	9.7	12
I-1 to I-2	80	10	12
I-2 to I-3	20	10	12
I-3 to I-4	50	13.8	16
I-4 to I-5	75	13.1	15
I-5 to I-6	130	14.5	17
I-6 to I-7	129	15.5	18
I-7 to I-8	130	17.5	20
I-8 to I-9	131	16.7	19
I-9 to I-10	130	16.3	18
I-10 to I-11	130	16	18

Number of manholes to be replaced

Manholes		11	manholes
	Depth of Manhole		
C-1	9.7	VLF	
I-2	10	VLF	
I-3	10	VLF	
I-4	13.8	VLF	
I-5	13.1	VLF	
I-6	14.5	VLF	
I-7	15.5	VLF	
I-8	17.5	VLF	
I-9	16.7	VLF	
I-10	16.3	VLF	
I-11	16	VLF	
Total depth	153	VLF	

Staging Area construction

Reference - RS Means 02 56 1310 0722 for 2017 in Queens, NY

Area of construction staging area			30,000 SF		
HDPE liner	30,000	SF	$1.83	=	$54,900

Perimeter requiring fencing 775 LF

Fencing installation duration

Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

	Duration	775 SF		300 LF/day		=	3	days
			Quantity	Unit	Unit Cost		Extended Cost	
	Labor and Equipment							
	Common building laborers (2)		3	day	$960	=	$2,880	
	Materials		775	LF	$5	=	$3,875	
	Subtotal					=	**$61,655**	

Sewer Flushing and Relining

Sewer will be flushed from I-1 to W-1 and C-1 to I-3.

	Flushing Duration	2,150 LF		195 LF/day		=	12	days
	Relining Duration	1,090 LF		90 LF/day		=	13	days
	Pipe cleaning and inspection		12	day	$6,000	=	$72,000	
	Relining		1,060	LF	$470	=	$498,200	
	Reconnecting		100	each	$500	=	$50,000	
	Subtotal						**$620,200**	

Road Removal

Assume width of road cut and excavation would be 8 feet for pipe diameters 12" - 24".

Assume 4-6" thick pavement.

Roadway to be removed		10,000 SF	
	=	1,112 SY	

Road removal

Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY

Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

	Duration - concrete	1,112 SY		200 SY/day		=	6	days
	Duration - asphalt r	1,112 SY		420 SY/day		=	3	days
			Quantity	Unit	Unit Cost		Extended Cost	
	Labor							
	Labor foreman		9	day	$467	=	$4,207	
	Laborers (2)		9	day	$889	=	$8,005	
	Equip. Oper. (light)		9	day	$579	=	$5,214	
	Equip. Oper. (medium)		9	day	$608	=	$5,475	
	Backhoe loader (48 HP)		9	day	$366	=	$3,296	
	Hyd. Hammer (1200 lbs)		9	day	$182	=	$1,640	
	Front end loader (4 CY)		9	day	$658	=	$5,918	
	Pavement rem. bucket		9	day	$58	=	$520	
	Subtotal					=	**$34,276**	

Soil Excavation and Sewer Pipe and Manhole Removal and Associated Sheeting

Volumes		
Non-contaminated soil above sewer line	4,317	BCY
Contaminated soil round and below sewer	704	BCY

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Excavation							
	Reference - RS Means 31 23 1613 1335 for 2017 in Queens, NY						
	Excavation production rate is reduced by 80% to account for hand digging around utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Exc. Duration	5,021 CY		230 CY/day	=	22	days
	Labor						
	Labor foreman	22	day	$467	=	$10,284	
	Laborers (2)	22	day	$889	=	$19,569	
	Equip. Oper. (medium)	22	day	$608	=	$13,383	
	Equip. Op. (heavy)	22	day	$633	=	$13,921	
	Hyd. Excavator (3.5 CY)	22	day	$2,401	=	$52,822	
	Dozer (80 HP)	22	day	$469	=	$10,309	
	Subtotal				**=**	**$120,288**	
Sewer pipe removal							
	Reference - RS Means 02 41 1323 2900 for 2017 in Queens, NY (pipe 12"diameter)						
	Reference - RS Means 02 41 1323 2930 for 2017 in Queens, NY (pipe 15"-18"diameter)						
	Reference - RS Means 02 41 1323 2960 for 2017 in Queens, NY (pipe 21"-24"diameter)						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration (12")	150 LF		35 LF/day	=	5	days
	Duration (15")	200 LF		30 LF/day	=	7	days
	Duration (24")	855 LF		24 LF/day	=	36	days
	Labor						
	Laborers (2)	48	day	$889	=	$42,695	
	Equip. Op. (heavy)	48	day	$633	=	$30,372	
	Hyd. Excavator (3.5 CY)	48	day	$2,401	=	$115,248	
	Subtotal				**=**	**$188,316**	
	Sewer bypass system	192	day	$5,000	=	**$960,000**	
Manhole removal							
	Reference - RS Means 02 41 1342 0100 for 2017 in Queens, NY						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration	153 VLF		2 VLF/day	=	96	days
	Labor						
	Laborers (2)	96	day	$889	=	$85,391	
	Equip. Op. (light)	96	day	$579	=	$55,619	
	Backhoe Loader	96	day	$366	=	$35,155	
	Subtotal				**=**	**$176,165**	

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Sheeting

It is assumed that due to utilities in the road and the depth of excavation, soldier piling and lagging walls would be required for sheeting.

Reference - RS Means 31 52 1610 0200 for 2017 in Queens, NY (for excavations 0-15 ft)
Reference - RS Means 31 52 1610 0500 for 2017 in Queens, NY (for excavations 15-22 ft)
Production rate is reduced by 40% to account for utilities.
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Sheeting Duration (production rate multipled by 2 for double crew)				92	days
Sheeting (0-15)	9,345 SF	594 SF/day	=	16	days
Sheeting (15-22	29,792 SF	396 SF/day	=	76	days

Labor	Quantity	Unit	Unit Cost		Extended Cost
Sheeting system (daily costs multiplied by 2 to account for double crew)					
Pile driver foreman (2)	92	day	$2,340	=	$215,295
Pile drivers (6)	92	day	$6,748	=	$620,801
Equip. Oper. (heavy) (2)	92	day	$2,531	=	$232,853
Equip. Oper. (oiler)	92	day	$1,091	=	$100,332
Laborers (3)	92	day	$2,668	=	$245,499
Crawler Crane (40 ton)	92	day	$2,626	=	$241,592
Lead, 60' high	92	day	$152	=	$13,984
Hammer, diesel	92	day	$1,212	=	$111,467
Air compressor (600 cfm)	92	day	$964	=	$88,688
50' air hoses (2)	92	day	$60	=	$5,483
Chain saw, gas (36 inches)	92	day	$90	=	$8,280

Materials

Assume that materials can be reused as crew moves from block to block.
Assume 3 sections of trench (one section is from manhole to manhole at approximately 200 length feet) would require sheeting at one time.

Sheeting	24000	SF	$11	=	$270,000
Subtotal				=	**$2,154,273**

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.
Assume samples will be shipped every week during excavation duration.

Total surface area of excavation (sidewalls and bottom)	58,080	SF
Number of samples	65	samples
Plus QC samples (10%)	72	samples

Field ISOCS gamma spec unit with l	1	month	$6,000	=	$6,000
Gamma spec analytical cost	72	each	$75	=	$5,400
Shipping	5	each	$200	=	$1,000
Subtotal				=	**$12,400**

Waste characterization sampling

Assume one sample per 500 CY.
Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.
Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	704	BCY	880	LCY	*Loose factor of 1.25*
Total samples	2	samples			

Sampling costs based on remedial investigation.

Radiological Analysis	2	samples	$75	=	$150
TCLP/TCL	1	samples	$1,200	=	$1,200
Shipping	5	each	$200	=	$1,000
Subtotal				=	**$2,350**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Sewer and Manhole Replacement and Restoration

Sewer pipeline replacement

Pipeline total to be replaced						
12" clay pipeline			150	feet		
15" clay pipeline			200	feet		
24" reinforced concrete pipeline			855	feet		
Duration						
Reference - RS Means 33 41 1360 2010 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2020 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2040 for 2017 in Queens, NY						
Production rate is reduced by 40% to account for utilities.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration -12"	150 LF		90 LF/day	=	2	days
Duration -15"	200 LF		90 LF/day	=	3	days
Duration -24"	855 LF		60 LF/day	=	15	days
Total Duration				=	20	days
Labor (for pipe diameters 12"-24")						
Labor foreman	20	day	$467	=	$9,349	
Laborers (4)	20	day	$1,779	=	$35,580	
Equip. Op. (light)	20	day	$579	=	$11,587	
Backhoe Loader (48 HP)	20	day	$366	=	$7,324	
Materials						
Pipeline 12"	150	LF	$17	=	$2,567	
Pipeline 15"	200	LF	$22	=	$4,416	
Pipeline 24"	855	LF	$31	=	$26,710	
Bedding material (6 inches)	4,840	LCY	$52	=	$251,680	
Subtotal				=	**$349,213**	

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PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Manhole Replacement

Duration						
Reference - RS Means 33 49 1310 0600 for 2017 in Queens, NY (8' deep)						
Reference - RS Means 33 49 1310 0700 for 2017 in Queens, NY (For depths over 8')						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Number of manholes to 8'	11	each				
Extra depth	65	VLF				
Duration for 8' VLF	11 each		0.7 each/day	=	16	days
Duration for extra c	65 VLF		5.5 VLF/day	=	12	days
					28	days
Labor and Materials						
Manholes to 8'				=	$59,264	
Extra depth				=	$51,245	
Subtotal				=	**$110,508**	

Backfill

Excavated clean soils testing for backfill						
Non-contaminated soil above sewer line		4,857	BCY			
VOC samples	15	each	$75	=	$1,125	
SVOCs	6	each	$145	=	$870	
Inorganics	6	each	$85	=	$510	
PCBs	6	each	$70	=	$420	
Pesticides	6	each	$65	=	$390	
Planning and sample collection	6	each	$200	=	$1,200	
Sample reporting	1	LS	$5,000	=	$5,000	
Subtotal				=	**$9,515**	
Common fill needed	*Loose factor of 1.25%*					
Contaminated soil round and below sewer		704	BCY	880	LCY	
Common fill	1,126	tons	$26	=	**$29,286**	
Duration						
Reference - RS Means 31 23 1613 3080 for 2017 in Queens, NY						
Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY						
Production rate is reduced by 80% to account for utilities.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration (fill)	1,126 LCY		120 LCY/day	=	10	days
Duration (compact)	9,640 SY		560 SY/day	=	18	days
Labor						
Laborers (2)	28	day	$889	=	$24,906	
Equip. Oper. (medium)	28	day	$608	=	$17,033	
Front end loader	28	day	$556	=	$15,574	
Compaction Roller	28	day	$183	=	$5,118	
Subtotal				=	**$62,631**	

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT		
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017		
	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Roadway restoration

Road to be replaced			10,000 SF			
			1,112 SY			
Duration						
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY						
Reference - RS Means 32 12 1613 0200 in Queens, NY						
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY						
Production rate is reduced by 80% to account for tight areas.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration - concrete	1,112 SY		600 SY/day	=	2	days
Duration - binder	1,112 SY		828 SY/day	=	2	days
Duration - wearing	1,112 SY		900 SY/day	=	2	days
Labor						
Labor foreman	6	day	$467	=	$2,805	
Laborers (7)	6	day	$3,113	=	$18,679	
Equip. Oper. (medium) (3)	6	day	$1,825	=	$10,950	
Rodman	2	day	$618	=	$1,235	
Cement finisher	2	day	$533	=	$1,065	
Grader	2	day	$966	=	$1,931	
Paving machine	2	day	$2,455	=	$4,910	
Asphalt paver	4	day	$2,235	=	$8,940	
Tandem roller	4	day	$238	=	$950	
Pneumatic wheel roller	4	day	$356	=	$1,423	
Materials						
Concrete (6")	1,112	SY	$41	=	$45,792	
Binder Course	1,112	SY	$23	=	$25,817	
Wearing Course	1,112	SY	$19.10	=	$21,238	
Subtotal				=	**$145,737**	

Duration of sewer line excavation, removal, and replacement is based on sheeting, pipe replacement, and manhole replacement due to concurrency of other tasks.

TOTAL DURATION OF ACTIVITY	**140 days**
TOTAL COST FOR SEWER LINE EXCAVATION, REMOVAL, AND REPLACEMENT	**$5,037,000**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

Assume an area of 25 feet by 27 feet with a depth of 4 feet of soils exceed PRGs and needs to be removed from below a concrete slab.

Foundation Removal

Assume foundation is slab-on-grade has a depth of 6 inches and is rod reinforced

Total volume of foundation to remove		675 SF		13 CY
		0.5 feet		

Removal Duration

Reference - RS Means 02 41 1916 0020 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	675 SF	175 SF/day	=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (4)	4	day	$1,779	=	$7,116
Air compressor	4	day	$181	=	$725
Pavement breaker (2)	4	day	$20	=	$82
50' air hoses (2)	4	day	$12	=	$46
Subtotal				=	**$9,839**

Soils Excavation

Total excavation volume of soils

Soil volume	100 BCY

Excavation Duration

Reference - RS Means 31 23 1616 0200 for 2017 in Queens, NY

Production rate is reduced by 20% to account for unknown conditions associated with data gaps for potentially impacted properties.

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	100 BCY	19 CY/day	=	6	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	6	day	$467	=	$2,805
Laborers (4)	6	day	$1,779	=	$10,674
Subtotal				=	**$13,479**

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area
104	4	=	416

Total surface area of excavation sidewalls	416	SF
Total surface area of excavation bottom	675	SF
Number of samples	2	samples
Plus QC samples (10%)	3	samples

Sampling costs based on remedial investigation.

Field ISOCS gamma spec unit with LabSOCS software	1	week	$2,000	=	$2,000
Gamma spec analytical cost	3	each	$75	=	$225
Shipping	1	each	$200	=	$200
Subtotal				=	**$2,425**

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	100	BCY	125	LCY
Total samples		1	samples	

Sampling costs based on remedial investigation.

Radiological Analysis	1	samples	$75	=	$75
TCLP/TCL	1	samples	$1,200	=	$1,200
Shipping	1	each	$200	=	$200
Subtotal				=	**$1,475**

Backfill

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Common fill needed	100	BCY	125	LCY
=	160	tons		

Duration

Reference - RS Means 31 23 2313 0400 for 2017 in Queens, NY

Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration (fill)	125 LCY	100	CY/day	=	2	days
Duration (compa	75 SY	2800	SY/day	=	1	days

Labor and Equipment

Laborers (2)	3	day	$889	=	$2,668
Equip. Oper. (medium)	3	day	$608	=	$1,825
Compaction Roller	3	day	$183	=	$548

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

Materials							
Common fill cost includes materials and trucking to site.							
Common fill		160	ton	$26	=	$4,160	
Subtotal					**=**	**$9,202**	

Concrete replacement

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Concrete			13	CY			
Duration							
Reference - RS Means 03 30 5340 4000 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	13 CY			39 CY/day	=	1	days
Labor and Equipment							
Labor foreman		1	day	$467	=	$467	
Laborers (4)		1	day	$1,779	=	$1,779	
Carpenters (6)		1	day	$3,357	=	$3,357	
Rodmen (2)		1	day	$1,234	=	$1,234	
Cement finisher		1	day	$532	=	$532	
Gas engine vibrator		1	day	$28	=	$28	
Subtotal					**=**	**$7,397**	

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**6 days**
TOTAL COST FOR OTHER IMPACTED BUILDINGS EXCAVATION	**$44,000**

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

09a - Transportation and Disposal

Construction material calculations presented in Appendix A.
Estimates are budgetary, include transportation to the disposal facility and disposal fee, and were given by I.C.E. Service Group for the year 2019.
Quantity calculation based on existing data.
Assume 0% bulking factor for construction materials (building and sewer).
Assumes 1.9 tons per CY of construction materials.
Assumes 1.6 tons per CY of soils.
Assumes debris to be less than 3'x3'x3'.
Assumes non-radiologically contaminated material/non-hazardous material would be transported to Pennsylvania (IESI/Progressive Waste Solutions).
Assumes radiologically-contaminated material would be transported to Idaho (US Ecology).
Assume radiologically-contaminated material mixed with TSCA waste would go to Texas (Waste Control Specialists).

Type	Quantity	Unit Cost	Extended Cost
Non-radiologically contaminated material	*tons*		
Non-radiologically-contaminated building materials	2,200	$100	$220,000
Sewer - pavement debris	400	$100	$40,000
Radiologically contaminated material	*tons*		
Radiologically-contaminated building materials	2,600	$435	$1,131,000
Pavement debris	1,300	$435	$565,500
Primary Excavation Soils	22,800	$435	$9,918,000
Secondary Excavation Soils	1,200	$435	$522,000
TSCA+Rad Soils	80	$700	$56,000
Sewer - Construction materials	80	$435	$34,800
Sewer - Soils	1,300	$435	$565,500
Decontamination water	*drums*		
Aqueous	1,470	$295	$433,650
Total	**31,960**		**$13,486,450**

TOTAL COST FOR TRANSPORTATION AND DISPOSAL **$13,487,000**

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

09b - Transportation and Disposal Associated Labor

Assume offsite loading would be performed concurrently to demolition, excavation, and sewer line activities.
Assume 15 trucks could depart the site on a daily basis with a load of 20 tons.

Duration of disposal for demolition						
	4,800 tons		300 tons/day	=	16	days
Duration of disposal for excavation						
	25,380 tons		300 tons/day	=	85	days
Duration of disposal for sewer materials						
	1,780 tons		300 tons/day	=	6	days

Labor and Equipment (during demolition)					
Laborers (2)	16	day	$889	=	$14,232
Traffic controllers (2)	16	day	$960	=	$15,360
Equip. Op. (heavy)	16	day	$633	=	$10,124
Hyd. Excavator (3.5 CY)	16	day	$2,401	=	$38,416
Subtotal				**=**	**$78,132**

Labor and Equipment (during excavation)

Because production rate of excavation is limited by the number of trucks that can be loaded each day on the site, it is assumed that equipment used for the excavation can also be used for loading.

Labor and Equipment (during sewer line)					
Laborers (2)	6	day	$889	=	$5,337
Traffic controllers (2)	6	day	$960	=	$5,760
Equip. Op. (heavy)	6	day	$633	=	$3,797
Hyd. Excavator (3.5 CY)	6	day	$2,401	=	$14,406
Subtotal				**=**	**$29,299**

TOTAL COST FOR TRANSPORTATION AND DISPOSAL	**$108,000**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

10 - Site Restoration

Backfill

Assume backfill will consist of common fill.

Assume backfill rate of 975 LCY per day.

					Loose factor of 25%		
Common fill needed			17,300 BCY		21,625 LCY		
	=		27,680 tons				
Duration							
Reference - RS Means 31 23 2314 2020 for 2017 in Queens, NY							
Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration (fill)	21,625 LCY		975 LCY/day		=	23	days
Duration (compact)	11,157 SY		2800 SY/day		=	4	days
Labor							
Laborers (2)		27	day	$889	=	$24,016	
Equip. Oper. (medium)		27	day	$608	=	$16,425	
Dozer (200 HP)		27	day	$556	=	$15,017	
Compaction Roller		27	day	$183	=	$4,936	
Materials							
Common fill cost includes materials and trucking to site.							
Common fill		27,680	ton	$26	=	$719,680	
Geotextile liner		6,516	SY	$2.50	=	$16,290	
Subtotal					**=**	**$796,364**	

Road/Asphalt Replacement

Road to be replaced			39,423 SF				
			4,390 SY				
Duration							
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0200 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration - concrete	4,390 SY		3,000 SY/day		=	2	days
Duration - binder	4,390 SY		4,140 SY/day		=	2	days
Duration - wearing	4,390 SY		4,500 SY/day		=	1	days
Labor							
Labor foreman		5	day	$467	=	$2,337	
Laborers (7)		5	day	$3,113	=	$15,566	
Equip. Oper. (medium) (3)		5	day	$1,825	=	$9,125	
Rodman		2	day	$618	=	$1,235	
Cement finisher		2	day	$533	=	$1,065	
Grader		2	day	$966	=	$1,931	
Paving machine		2	day	$2,455	=	$4,910	
Asphalt paver		3	day	$2,235	=	$6,705	
Tandem roller		3	day	$238	=	$713	
Pneumatic wheel roller		3	day	$356	=	$1,067	
Materials							
Binder Course		4,390	SY	$23	=	$101,923	
Wearing Course		4,390	SY	$19	=	$83,845	
Subtotal					**=**	**$230,422**	

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

10 - Site Restoration

Sidewalk Replacement

Assume a 6-inch sidewalk will be installed.

Total area of sidewalk to install			7,819 SF				
Duration							
Reference - RS Means 32 06 1010 0310 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	7,819 SF		1,200 SF/day		=	7	days
Labor							
Laborers (2)		7	day	$889	=	$6,226	
Cement Finisher(2)		7	day	$1,063	=	$7,443	
Carpenter (2)		7	day	$1,119	=	$7,833	
Subtotal					**=**	**$21,502**	
Materials							
Concrete, 4" thick		7,819	SF	$3	=	$25,648	
Subtotal					**=**	**$25,648**	

Topsoil Placement and Seeding

Assume 6 inches of topsoil will be placed on the property.

Topsoil needed			49,560 SF				
			5,507 SY		918 BCY		
Depth			0.5 feet		1148 LCY		
Duration of topsoil placement							
Reference - RS Means 32 91 1913 0400 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	1,148 CY		120 CY/day		=	10	days
Duration of fine grading and seeding							
Reference - RS Means 32 92 1913 0310 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	5,507 SY		1,000 SY/day		=	6	days
Labor							
Labor foreman		16	day	$467	=	$7,479	
Laborers (2)		16	day	$889	=	$14,232	
Equip. Oper. (medium)		16	day	$608	=	$9,733	
Backhoe/FE loader		16	day	$658	=	$10,522	
Subtotal					**=**	**$41,966**	
Materials							
Topsoil		1,148	CY	$40	=	$45,920	
Seed, lime, fertilizer		1,148	SY	$4	=	$4,592	
Subtotal					**=**	**$50,512**	

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
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Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

10 - Site Restoration

Fencing to secure property

Perimeter requiring fencing		800	LF			
Fencing installation duration						
Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration	800 SF		300 LF/day	=	3	days
		Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment						
Common building laborers (2)		3	day	$889	=	**$2,668.46**
Materials		800	LF	$5	=	**$4,000**

Final Status Survey

Assume gross gamma measurements and exposure rate measurements will be collected.

Based on previous work completed at the site.

Surface area		58,080 SF				
Gamma exposure rate measurements		8				
Duration						
Assume production rate of 12000 SF per day						
Duration - scan survey	58,080 SF	12,000 SF/day		=	5	days
Duration - exposure rates	8 each	2 each/day		=	4	days
Labor						
Labor and equipment are accounted for in general requirements						
NaI detector	2	week	$160	=	$320	
Borehole probes	2	week	$150	=	$300	
GPS	9	day	$640	=	$5,760	
Final Status Survey Plan	1	LS	$25,000	=	$25,000	
Final Status Survey Report	1	LS	$25,000	=	$25,000	
Subtotal				=	**$56,380**	

Duration of restoration is based on duration of backfill, sidewalk placement, and the final status survey due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**52 days**
TOTAL COST FOR SITE RESTORATION	**$1,230,000**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

11 - Soil Cover Inspection and Maintenance

Assume inspection and maintenance will continue for 30 years.

Inspection and Maintenance

Assume 3% of backfill costs for maintenance every year for a default period of 30 years.

Annual allowance for inspection and annual report	1	LS	$7,500	=	$7,500
Soil cover maintenance	1	LS	$30,804	=	$30,804
Subtotal				=	**$38,304**

Groundwater monitoring

Number of monitoring wells	6	wells			
Number of samplers	2	samplers			
Number of 8 hour workdays	1	day			
Mob/demob					
Project Manager	4	hr	$160	=	$ 640
Engineer	8	hr	$110	=	$ 880
Field Tech	24	hr	$85	=	$ 2,040
Sampling					
Field Tech 1	8	hour	$85	=	$ 680
Geologist	8	hour	$100	=	$ 800
Per diem	8	day	$181	=	$ 1,448
Car rental	2	day	$95	=	$ 190
Equipment & PPE	1	LS	$200	=	$ 200
Shipping	1	day	$75	=	$ 75
Misc	1	day	$100	=	$ 100
Sampling Analysis (includes QC samples)					
Gamma spectroscopy	7	ea	$100	=	$ 700
Reporting					
Project manager	8	hour	$150	=	$1,200
Scientist	24	hour	$100	=	$2,400
QA/QC	4	hour	$110	=	$440
Data validation	3.5	hr	$150	=	$ 525
Tabulate the data and prepare figures	1	LS	$3,000	=	$ 3,000
Prepare the data report	1	LS	$5,000	=	$ 5,000
Clerk	8	hour	$75	=	$600
Subtotal				=	**$20,918**
TOTAL ANNUAL COST FOR COVER O&M AND GW MONITORING					**$60,000**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 3 - Individual Cost Item Backup

11 - Soil Cover Inspection and Maintenance

Present Worth Calculation for Inspection and Maintenance Costs

This is a recurring cost every year.

This discount factor is (P/A,i,n)

P = Present Worth

A = Annual amount

i = interest rate	7%	
n = number of years	30	

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

The multiplier for (P/A) =	**12.4**	
TOTAL INSPECTION, MAINTENANCE, and MONITORING COST:		**$745,000**

Appendix F-3
Cost Estimate for Alternative 4
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

No.	Description	Cost
	Remedial Action	
01	Permanent relocation	$625,000
02	General requirements	$3,457,000
03	Site preparation/site work	$395,000
04	Demolition and segregation	$223,000
05	Excavation and segregation	$2,354,266
06	Post-excavation sampling	$63,000
07	Sewer line excavation, removal, and replacement	$5,037,000
08	Other impacted buildings excavation and restoration	$44,000
09a	Transportation and disposal costs	$16,227,000
09b	Transportation and disposal labor	$108,000
10	Restoration and Final Status Survey	$1,247,000
	Subtotal for Construction Activities	*$12,929,000*
	Subtotal for Transportation and Disposal	*$16,227,000*
	Contingency on Construction Activities (20%)	$2,586,000
	Contingency on Transportation and Disposal (20%)	$3,246,000
	Subtotal for Construction Activities	*$15,515,000*
	Subtotal for Transportation and Disposal	*$19,473,000*
	General Contractor Bond and Insurance - Construction Activities (5%)	$776,000
	General Contractor Bond and Insurance - Transportation and Disposal (5%)	$974,000
	Subtotal for Construction Activities	*$16,291,000*
	Subtotal for Transportation and Disposal	*$20,447,000*
	General Contractor Markup - Construction Activities (10%)	$1,630,000
	General Contractor Markup - Transportation and Disposal (2%)	$409,000
	Subtotal of Remedial Action Construction Activities	$17,921,000
	Subtotal of Remedial Action Transportation and Disposal	$20,856,000
	Subtotal of Relocation	$625,000
	PRESENT WORTH	
	Total Capital Cost (including relocation)	**$39,402,000**
	Total O&M Cost	**$0**
	Total Present Worth	**$39,402,000**

Note: The project cost presented herein represents only feasibility study level, and is thus, subject to change pending the results of the pre-design investigation, which is intended to collect sufficient data to assist in the development of remedial design and associated detailed cost estimate. Expected accurant range of the cost estimate is -30% to +50% ($27,581,400 to $59,103,000).
The estimate is prepared solely to facilitate relative comparisons between feasibility study alternatives for evaluation.
The costs do not include costs for project management and construction management, remedial design, pre-design investigation, or relocation.
Reference: EPA. A Guide to Developing Cost Estimates During the Feasibility Study. 540-R-00-002. July 2000.

CDM Smith

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

01 - Permanent Relocation

Block	Lot	Owner	Tenant	Address
3725	33	Unique Development	Empty warehouse, no tenant	11-33 Irving Avenue
	42	LPL Properties, Inc.	Primo Auto Body and TerraNova	11-29 Irving Avenue
	44	LPL Properties, Inc.	Celtic Bike Shop	11-27 Irving Avenue
	46	Second A-One	Jarabacoa Deli	11-25 Irving Avenue
	48	Rudy Reyes	K&M Auto Repair	15-14 Cooper Avenue

Permanent Relocation for Tenants of Lot 42, 44, 46, and 48

Costs are estimated following 49 CFR 24 - Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs.
Costs are estimated based on relocation costs incurred at another Ragion 2 Superfund Site in the tri-state area.
Estimate for incremental rent is based on an increase of $500 in rent per month for 42 months.

	Quantity	Unit	Unit Cost		Extended Cost
Reestablishment Costs	5	each	$25,000	=	$125,000
Search expenses	5	each	$2,500	=	$12,500
Related expenses	5	each	$25,000	=	$125,000
Incremental rent for 42 months	5	each	$21,000	=	$105,000
Moving expenses	5	each	$40,000	=	$200,000
				Subtotal	**$567,500**
Admininistration costs	1	LS	$56,750	=	**$56,750**
TOTAL COST FOR PERMANENT RELOCATION					**$625,000**

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	JOB NO.: 101995.3323.054	DATE: 7/13/2017	DATE CHECKED: 7/14/2017
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Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

02 - General Requirements

Project Schedule

Assume the following construction schedule.

Pre-construction work plans and meetings	3 months	13 weeks
Construction Period		
Field mobilization and site preparation	1 months	5 weeks
Building demolition	2 months	9 weeks
Soil excavation (including roadway)	4 months	18 weeks
Sewer line excavation, removal, and replacement	5 months	22 weeks
Site restoration and demobilization	2 months	9 weeks
Total construction duration	*14 months*	*61 weeks*
Total project duration in months	**17 months**	
Total project duration in weeks	**74 weeks**	

General Conditions

A) Project Management and Site Supervisory

Assume the following staff for the duration of project with Project Manager at 16 hours/week, Project Engineer at 20 hours/week, and procurement staff at 10 hours/week.

	Quantity	Unit	Unit Cost		Extended Cost
Project Manager	1,184	hr	$150	=	$177,600
Project Engineer	1,480	hr	$110	=	$162,800
Procurement staff	740	hr	$90	=	$66,600
Scheduler	136	hr	$100	=	$13,600
Total management and office support					$420,600

B) Work Plan Preparation

Estimated # of Pre-Construction Work Plans Required:	15	work plans
Estimated # of Engineer Hours Required per Work Plan:	60	hours each
Estimated # of Project Manager Hours Required per Work Plan:	2	hours each

	Quantity	Unit	Unit Cost		Extended Cost
Project Engineer	900	hr	$110	=	$99,000
Project Manager (half time)	15	hr	$150	=	$2,250
Total Work Plan Preparation Cost					$101,250

C) Remedial Action Report

	Quantity	Unit	Unit Cost		Extended Cost
Project Engineer	400	hr	$110	=	$44,000
Project Manager	60	hr	$150	=	$9,000
Total Remedial Action Report Preparation Cost					$53,000

D) Permits

	Quantity	Unit	Unit Cost		Extended Cost
Permit Specialist	250	hr	$125	=	$31,250
Project Manager	120	hr	$150	=	$18,000
Total Permitting Cost					$49,250

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

02 - General Requirements

E) Onsite supervisory

Assume the following full time site supervisory staff for the duration of construction.

Assume 40 hours per week.

Assume construction foreman would be local and not require a truck.

Site Superintendent	2,440	hr	$150	=	$366,000
Construction Foreman	2,440	hr	$100	=	$244,000
Onsite QC Engineer	2,440	hr	$110	=	$268,400
Scheduler	2,440	hr	$100	=	$244,000
Pickup Truck #1	305	day	$100	=	$30,500
Pickup Truck #2	305	day	$100	=	$30,500
Total Onsite Supervisory Staff for Total Construction Duration (61 weeks)					$1,183,400
Subtotal General Conditions:					**$1,808,000**

Safety and Health Requirements

Safety and Health Requirements to include the Site Health and Safety Officer (SHSO)/Medium level health physicist, personnel protective

Assume PPE required for 20 people per work day for the duration of construction activities.

The radiological services cost are used from the remedial investigation bid sheet accounting for 3% escalation.

Assume senior health physicist time at 8 hours per month.

Assume a crew of 20 would be onsite.

SHSO/Med. Health Physicist	2440	hr	$62	=	$150,304
Junior Technician	2440	hr	$50	=	$122,976
Senior Health Physicist	112	hr	$112	=	$12,544
Equipment					
SKC PCXR4 lapel sampling pumps	14	month	$720	=	$10,080
Bios Defender calibrator	14	month	$200	=	$2,800
Ludlum 2929/43-10-1 alpha/beta sample counter	14	month	$480	=	$6,720
Ludlum 2360/43-93 alpha beta field meters	14	month	$720	=	$10,080
Ludlum model 2221/44-9 alpha/beta/gamma probe	14	month	$225	=	$3,150
Ludlum Model 9P pressurized ion chamber survey met	14	month	$200	=	$2,800
Work area air monitor	14	month	$165	=	$2,310
perimeter radiological air	14	month	$2,500	=	$35,000
Dust monitors	14	month	$1,450	=	$20,300
Filter media, smear	14	month	$50	=	$700
Radiation Badges	1360	each	$39	=	$53,312
PPE	305	day	$140	=	$854,000
Additional Safety and Air Monitoring Equipment			10%	=	$85,400
					$1,372,476

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

02 - General Requirements

Temporary Facilities

Temporary Facilities to include the field trailers, utilities, cleaning services, and office equipment and supplies.

Assume four project trailers required (2 for Contractor, 1 for EPA, and 1 shower trailer)

Reference - RS Means 01 52 20 Construction Facilities for 2017 in Queens, NY.

Work space rental	14	month	$904	=	$12,656
Electricity	14	month	$177	=	$2,478
Electricity hookup	1	LS	$10,000	=	$10,000
Phone/Internet	14	month	$95	=	$1,330
Water/Sewer	14	month	$60	=	$840
Cleaning service and others	14	month	$300	=	$4,200
					$31,504

Security

Assume for duration of construction requires 16-hour security guard for weekdays and 24-hour security guard for weekends for the entire

Security trailer rental	14	month	$200	=	$2,800
Security guard	8,064	hours	$30	=	$241,920
					$244,720

TOTAL COST FOR GENERAL REQUIREMENTS	**$3,457,000**

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

03 - Site Work

Assume cars and mechanic-related materials will be removed from the property as part of relocation.
Assume staging area for demolition will be in the former rail spur area.
Assume excavation will be completed in phases to account for the limited site area.

Clearing and Grubbing

Assume clearing in the former rail spur area.
Assume staging area will be in the former rail spur area.
Reference - RS Means 31 11 1010 0010 Clear and Grub Site for 2017 in Queens, NY.

	Quantity	Unit	Unit Cost		Extended Cost
Clearing and grubbing	43,500	SF	$0.10	=	$4,350

Mobilization of Construction Equipment

Field mobilization (allowance)	1	LS	$75,000	=	$75,000

Surveying

Survey would be conducted duration excavation and sewer line removal.

Surveyor onsite during sewer removal and excavation period (for depth verification, quantity measurement, waste char. samples).
Assume surveyor time at 10 hours per week.

Total Surveying Duration 40 weeks

	Quantity	Unit	Unit Cost		Extended Cost
Professional Surveyor	40	hr	$120	=	$4,800
Surveyor	400	hr	$75	=	$30,000
Assistant Surveyor	400	hr	$65	=	$26,000
Submittals	1	LS	$20,000	=	$20,000
					$80,800

Erosion Control

Assume daily output of silt fencing at 1,300 LF and hay bales at 2,500 LF.
Reference - RS Means 31 25 1416 1000 for 2017 in Queens, NY
Reference - RS Means 31 25 1416 1250 Clear and Grub Site for 2017 in Queens, NY

Total excavation and backfill duration 49 weeks
Length of erosion control measure 2225 LF

	Quantity	Unit	Unit Cost		Extended Cost
Silt fence	2225	LF	$2.44	=	$5,429
Hay bale	2225	LF	$7.15	=	$15,909
Maintenance (10%)	49	week	$542.90	=	$26,602
					$47,940

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

03 - Site Work

Decontamination

Assume decontamination pad required during construction.

Assume decontamination water will be used for dust suppression.

Duration of construction			49 weeks		
	Quantity	Unit	Unit Cost		Extended Cost
Construction of decontamination pad					
	1	LS	$10,000	=	$10,000
Decontamination operation					
Assume 2 workers for 2 hours per day to perform equipment decontamination on-site including T&D trucks.					
Laborers (2)	490	day	$120	=	$58,800
Assume 15 trucks per day at 20 gallons per truck of steam cleaning.					
Assume 55-gallon drums filled to 50 gallons.					
Decon water produced	300	gals/day	73,500	gallons	
Drums	1,470	drum	$80	=	$117,600
Subtotal					$186,400
TOTAL COST FOR SITE WORK					**$395,000**

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JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

04 - Building Demolition and Construction Debris Disposal

Building is a mixture of steel, concrete, and masonry.
Assume building foundation is 6-inch concrete with reinforced rods.
Assume building demolition rate of 20100 CF per day.
Assume foundation demolition rate of 4000 CF per day.

Building Demolition - Lot 33

Standing building volume		
Building footprint	12,375	SF
Building height	14	LF
Volume of building	173,250	CF
Standing building volume - Lot 42 and 44		
Buildings footprint	13,175	SF
Building height	14	LF
Volume of building	184,450	CF
Standing building volume - Lot 46		
Building footprint	5,000	SF
Building height	26	LF
Volume of building	130,000	CF
Standing building volume - Lot 48		
Building footprint	1,145	SF
Building height	13	LF
Volume of building	14,885	CF

Assume 6-inch concrete, reinforced rods foundation.

Building foundation volume		
Building footprint	12,375	SF
Foundation thickness	0.5	feet
Volume of building	6,188	CF
Building foundation volume - Lot 42 and 44		
Building footprint	13,175	SF
Foundation thickness	0.5	feet
Volume of building	6,588	CF
Building foundation volume - Lot 46		
Building footprint	5,000	SF
Foundation thickness	0.5	feet
Volume of building	2,500	CF
Building foundation volume - Lot 48		
Building footprint	1,145	SF
Foundation thickness	0.5	feet
Volume of building	573	CF

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

04 - Building Demolition and Construction Debris Disposal

Asbestos and Lead Paint Abatement

An initial hazardous building materials survey was completed for the site and found asbestos and lead at volume typical of a building at this age.

Asbestos Abatement	1	LS	$20,000	=	$20,000
Lead paint abatement	1	LS	$15,000	=	$15,000

Demolition of standing building

Reference - RS Means 02 41 1613 0100 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	502,585	CF	20,100	CF/day	=	26	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	26	day	$467	=	$12,154
Laborers (2)	26	day	$889	=	$23,127
Equip. Oper. (medium) (2)	26	day	$1,217	=	$31,633
Equip. Oper. (oiler)	26	day	$545	=	$14,177
Hyd. Excavator (3.5 CY)	26	day	$2,401	=	$62,426
Hydraulic Crane (25 ton)	26	day	$674	=	$17,519

Demolition of foundation including slab

Assume footings would be removed as part of the excavation.

Reference - RS Means 02 41 1617 0400 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	31,695	SF	4,000	SF/day	=	8	days

Labor and Equipment					
Equip. Oper. (heavy) (2)	8	day	$1,266	=	$10,124
Hyd. Excavator, 1.5 CY	8	day	$965	=	$7,720
Hyd. Hammer (5,000 lbs)	8	day	$376	=	$3,010
Hyd. Excavator, 0.75 CY	8	day	$674	=	$5,394

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY **34 days**

TOTAL COST FOR BUILDING DEMOLITION **$223,000**

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	JOB NO.: 101995.3323.054	DATE: 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

05 - Soils Excavation

Road Removal

Assume road paving is 4 inch depth.

See Figure 3-3 for areas of road to remove.

Total area of roadway to remove			39,423 SF				
			4,390 SY				

Removal Duration

Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY

Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration - concrete	4,390 SY	200 SY/day	=	22	days
Duration - asphalt re	4,390 SY	420 SY/day	=	11	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	33	day	$467	=	$15,426
Laborers (2)	33	day	$889	=	$29,353
Equip. Oper (light)	33	day	$579	=	$19,119
Equip. Oper. (medium)	33	day	$608	=	$20,075
Backhoe loader (48 HP)	33	day	$366	=	$12,085
Hyd. Hammer (5,000 lbs)	33	day	$182	=	$6,013
Front end loader (4 CY)	33	day	$658	=	$21,701
Pavement rem. bucket	33	day	$58	=	$1,907
Subtotal				=	**$125,679**

Sidewalk Removal

Assume sidewalk has 6 inch depth.

See Figure 3-3 for areas of sidewalk to remove.

Total volume of sidewalk to remove			7,819 SF				
			870 SY				

Removal Duration

Reference - RS Means 02 41 1317 5200 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	870 SY	255 SY/day	=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (2)	4	day	$889	=	$3,558
Equip. Oper (light)	4	day	$579	=	$2,317
Equip. Oper. (medium)	4	day	$608	=	$2,433
Backhoe loader (48 HP)	4	day	$366	=	$1,465
Hyd. Hammer (1200 lbs)	4	day	$182	=	$729
Front end loader (4 CY)	4	day	$658	=	$2,630
Pavement rem. bucket	4	day	$58	=	$231
Subtotal				=	**$15,234**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

05 - Soils Excavation

Soldier Piling

Assume no hydrostatic head, one line of braces, with 3-inch wood sheeting.

Length and surface requiring piling					
6-foot excavation		445 LF		2,670 SF	
8-foot excavation		127 LF		1016 SF	
Subtotal		*572 LF*		*3,686 SF*	
20-foot excavation perimeter		410 LF		8,200 SF	
30-foot excavation perimeter		375 LF		7,500 SF	

Piling Installation Duration

Reference - RS Means 31 52 1610 0200 for 2017 in Queens, NY (for excavations 0-15 ft)
Reference - RS Means 31 52 1610 0500 for 2017 in Queens, NY (for excavations 15-22 ft)
Reference - RS Means 31 52 1610 0800 for 2017 in Queens, NY (for excavations 23-35 ft)
Production rate is reduced by 40% to account for the congested site area.
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Sheeting Duration (production rate multipled by 2 for double crew)				71	days
Sheeting (0-15)	3,686 SF	594 SF/day	=	7	days
Sheeting (15-22)	8,200 SF	396 SF/day	=	21	days
Sheeting (23-35)	7,500 SF	177 SF/day	=	43	days

Labor	Quantity	Unit	Unit Cost		Extended Cost
Sheeting system (daily costs multiplied by 2 to account for double crew)					
Pile driver foreman (2)	71	day	$2,340	=	$166,151
Pile drivers (6)	71	day	$6,748	=	$479,097
Equip. Oper. (heavy) (2)	71	day	$2,531	=	$179,702
Equip. Oper. (oiler)	71	day	$1,091	=	$77,430
Laborers (3)	71	day	$2,668	=	$189,461
Crawler Crane (40 ton)	71	day	$2,626	=	$186,446
Lead, 60' high	71	day	$152	=	$10,792
Hammer, diesel	71	day	$1,212	=	$86,024
Air compressor (600 cfm)	71	day	$964	=	$68,444
50' air hoses (2)	71	day	$60	=	$4,232
Chain saw, gas (36 inches)	71	day	$90	=	$6,390
Materials	19,386	SF	$11	=	$218,093
Subtotal				=	**$1,672,260**

Fencing to secure excavation

Perimeter requiring fencing 1,995 LF

Fencing installation duration

Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	1,995 SF	300 LF/day	=	7	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Common building laborers (2)	7	day	$889	=	**$6,226.42**
Materials	1,995	LF	$5	=	**$9,975**

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	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

05 - Soils Excavation

Soils Excavation

Total excavation volume of soils

See Appendix C-3 for soil volume calculations and Figure 3-5 for excavation areas.

Soldier piling will be used for excavations deeper than 4 feet bgs.

Soil volume	18,000	BCY
Secondary volume (5%)	900	BCY

Excavation Duration

Reference - RS Means 31 23 1642 0305 for 2017 in Queens, NY

Excavation production rate is limited by the transportation and disposal offsite rate. (Cost Item 9)

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	18,000	BCY	188	CY/day	=	96	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	96	day	$467	=	$44,877
Laborers (2)	96	day	$889	=	$85,391
Equip. Oper. (medium)	96	day	$608	=	$58,399
Equip. Op. (heavy)	96	day	$633	=	$60,744
Hyd. Excavator (3.5 CY)	96	day	$2,401	=	$230,496
Dozer (80 HP)	96	day	$469	=	$44,986
Subtotal				=	**$524,893**

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**96 days**
TOTAL COST FOR SOIL EXCAVATION	**$2,354,266**

CDM Smith	PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
	JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
	CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

06 - Post-excavation Sampling

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area
152	2	=	304
712	2	=	1424
105	2	=	210
59	2	=	118
40	30	=	1200
272	28	=	7616
65	10	=	650
47	20	=	940
54	18	=	972
30	20	=	600
53	18	=	954
41	14	=	574
16	16	=	256
101	18	=	1818
14	4	=	56
165	6	=	990
44	4	=	176
94	6	=	564
26	6	=	156
27	8	=	216
834	2	=	1668
156	4	=	624
85	2	=	170
335	2	=	670
100	6	=	600
100	8	=	800

Total surface area of excavation bottom	103,785	SF	See Appendix D
Total surface area of excavation sidewalls	24,326	SF	
Total surface area	128,111	SF	
Number of samples	143	samples	
Plus QC samples (10%)	158	samples	

Sampling costs based on remedial investigation.

Field ISOCS gamma spec unit with LabSOCS software	4	month	$6,000	=	$24,000
Gamma spec analytical cost	158	each	$75	=	$11,850
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	18	each	$200	=	$3,600
Subtotal				=	**$44,450**

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	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

06 - Post-excavation Sampling

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	18,000	BCY	22,500	LCY	
Total samples		45	samples		
Sampling costs based on remedial investigation.					
Radiological Analysis	45	samples	$75	=	$3,375
TCLP/TCL	5	samples	$1,200	=	$6,000
Sample reporting	1	LS	$5,000	=	$5,000
Shipping	18	each	$200	=	$3,600
Subtotal				**=**	**$17,975**
TOTAL COST FOR POST-EXCAVATION SAMPLING					**$63,000**

PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT	
JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017	
CLIENT: EPA			

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Assume overlying soil above sewer pipe is clean and will be segregated, stockpiled, sampled, and used as backfill after replacement of the new sewer pipe.

Assume overlying soil is removed with excavator and soil on either side of the sewer pipe is hand dug.

Assume 2 feet of soil beneath sewer pipeline is contaminated and will be segregated for offsite disposal.

Assume sewer line removal occurs after building demolition and soils excavation; therefore, the WACC property will be used as staging.

Pipeline total to be removed (I-1 to I-4, I-4 to I-11, C-1 to I-3)			Sewer line length
12" clay pipeline	150	feet	I-1 to I-4
24" pipeline	855	feet	I-4 to I-11
15" clay pipeline	200	feet	C-1 to I-3
Total length	1,210	feet	

Total length to be flushed (I-4 to W-1, C-1 to I-3)			
15" clay pipeline	200	feet	C-1 to I-3
24" pipeline	986	feet	I-4 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be flushed	2,150	feet	

Total length to be relined (I-11 to W-1)			
24" pipeline	131	feet	I-11 to I-12
36" pipeline	955	feet	I-12 to W-1
Total length to be relined (I-11 to W-1)	1,090	feet	

Assume depth of excavation is the depth of the end point pipeline manhole.

Pipeline Section	Length	Depth of Manhole (VLF)	Depth of Excavation (VLF)
C-1 to I-3	200	9.7	12
I-1 to I-2	80	10	12
I-2 to I-3	20	10	12
I-3 to I-4	50	13.8	16
I-4 to I-5	75	13.1	15
I-5 to I-6	130	14.5	17
I-6 to I-7	129	15.5	18
I-7 to I-8	130	17.5	20
I-8 to I-9	131	16.7	19
I-9 to I-10	130	16.3	18
I-10 to I-11	130	16	18

Number of manholes to be replaced

Manholes 11 manholes

	Depth of Manhole	
C-1	9.7	VLF
I-2	10	VLF
I-3	10	VLF
I-4	13.8	VLF
I-5	13.1	VLF
I-6	14.5	VLF
I-7	15.5	VLF
I-8	17.5	VLF
I-9	16.7	VLF
I-10	16.3	VLF
I-11	16	VLF
Total depth	153	VLF

Staging Area construction

Reference - RS Means 02 56 1310 0722 for 2017 in Queens, NY

Area of construction staging area 30,000 SF

HDPE liner	30,000	SF	$1.83	=	$54,900

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PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement								
	Perimeter requiring fencing		775	LF				
	Fencing installation duration							
	Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY							
	Labor rates assume 1.42 overhead rate on top of bare labor rates.							
	Duration	775 SF			300 LF/day	=	3	days
			Quantity	Unit	Unit Cost		Extended Cost	
	Labor and Equipment							
	Common building laborers (2)		3	day	$960	=	$2,880	
	Materials		775	LF	$5	=	$3,875	
	Subtotal					=	**$61,655**	
Sewer Flushing and Relining								
Sewer will be flushed from I-1 to W-1 and C-1 to I-3.								
	Flushing Duration	2,150 LF			195 LF/day	=	12	days
	Relining Duration	1,090 LF			90 LF/day	=	13	days
	Pipe cleaning and inspection		12	day	$6,000	=	$72,000	
	Relining		1,060	LF	$470	=	$498,200	
	Reconnecting		100	each	$500	=	$50,000	
	Subtotal						**$620,200**	
Road Removal								
Assume width of road cut and excavation would be 8 feet for pipe diameters 12" - 24".								
Assume 4-6" thick pavement.								
	Roadway to be removed				10,000 SF			
			=		1,112 SY			
Road removal								
	Reference - RS Means 02 41 1317 5300 for 2017 in Queens, NY							
	Reference - RS Means 02 41 1317 5050 for 2017 in Queens, NY							
	Labor rates assume 1.42 overhead rate on top of bare labor rates.							
	Duration - concrete r	1,112 SY			200 SY/day	=	6	days
	Duration - asphalt rer	1,112 SY			420 SY/day	=	3	days
			Quantity	Unit	Unit Cost		Extended Cost	
	Labor							
	Labor foreman		9	day	$467	=	$4,207	
	Laborers (2)		9	day	$889	=	$8,005	
	Equip. Oper. (light)		9	day	$579	=	$5,214	
	Equip. Oper. (medium)		9	day	$608	=	$5,475	
	Backhoe loader (48 HP)		9	day	$366	=	$3,296	
	Hyd. Hammer (1200 lbs)		9	day	$182	=	$1,640	
	Front end loader (4 CY)		9	day	$658	=	$5,918	
	Pavement rem. bucket		9	day	$58	=	$520	
	Subtotal					=	**$34,276**	
Soil Excavation and Sewer Pipe and Manhole Removal and Associated Sheeting								
	Volumes							
	Non-contaminated soil above sewer line			4,317	BCY			

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement								
	Contaminated soil round and below sewer		704	BCY				
Excavation								
	Reference - RS Means 31 23 1613 1335 for 2017 in Queens, NY							
	Excavation production rate is reduced by 80% to account for hand digging around utilities.							
	Labor rates assume 1.42 overhead rate on top of bare labor rates.							
	Exc. Duration	5,021 CY		230 CY/day		=	22	days
	Labor							
	Labor foreman	22	day	$467		=	$10,284	
	Laborers (2)	22	day	$889		=	$19,569	
	Equip. Oper. (medium)	22	day	$608		=	$13,383	
	Equip. Op. (heavy)	22	day	$633		=	$13,921	
	Hyd. Excavator (3.5 CY)	22	day	$2,401		=	$52,822	
	Dozer (80 HP)	22	day	$469		=	$10,309	
	Subtotal					=	**$120,288**	
Sewer pipe removal								
	Reference - RS Means 02 41 1323 2900 for 2017 in Queens, NY (pipe 12"diameter)							
	Reference - RS Means 02 41 1323 2930 for 2017 in Queens, NY (pipe 15"-18"diameter)							
	Reference - RS Means 02 41 1323 2960 for 2017 in Queens, NY (pipe 21"-24"diameter)							
	Production rate is reduced by 80% to account for utilities.							
	Labor rates assume 1.42 overhead rate on top of bare labor rates.							
	Duration (12")	150 LF		35 LF/day		=	5	days
	Duration (15")	200 LF		30 LF/day		=	7	days
	Duration (24")	855 LF		24 LF/day		=	36	days
	Labor							
	Laborers (2)	48	day	$889		=	$42,695	
	Hyd. Excavator (3.5 CY)	48	day	$2,401		=	$115,248	
	Equip. Op. (heavy)	48	day	$633		=	$30,372	
	Subtotal					=	**$188,316**	
	Sewer bypass system	192	day	$5,000		=	**$960,000**	
Manhole removal								
	Reference - RS Means 02 41 1342 0100 for 2017 in Queens, NY							
	Production rate is reduced by 80% to account for utilities.							
	Labor rates assume 1.42 overhead rate on top of bare labor rates.							
	Duration	153 VLF		2 VLF/day		=	96	days
	Labor							
	Laborers (2)	96	day	$889		=	$85,391	
	Equip. Op. (light)	96	day	$579		=	$55,619	
	Backhoe Loader	96	day	$366		=	$35,155	
	Subtotal					=	**$176,165**	

PROJECT: Wolff-Alport	**COMPUTED BY :** KK	**CHECKED BY:** FT	
JOB NO.: 101995.3323.054	**DATE :** 7/13/2017	**DATE CHECKED:** 7/14/2017	
CLIENT: EPA			

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Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Sheeting

It is assumed that due to utilities in the road and the depth of excavation, soldier piling and lagging walls would be required for sheeting.

Reference - RS Means 31 52 1610 0200 for 2017 in Queens, NY (for excavations 0-15 ft)
Reference - RS Means 31 52 1610 0500 for 2017 in Queens, NY (for excavations 15-22 ft)
Production rate is reduced by 40% to account for utilities.
Labor rates assume 1.42 overhead rate on top of bare labor rates.

Sheeting Duration (production rate multipled by 2 for double crew)						92	days
Sheeting (0-15)	9,345	SF	594	SF/day	=	16	days
Sheeting (15-22)	29,792	SF	396	SF/day	=	76	days

Labor

Sheeting system (daily costs multiplied by 2 to account for double crew)

Pile driver foreman (2)	92	day	$2,340	=	$215,295
Pile drivers (6)	92	day	$6,748	=	$620,801
Equip. Oper. (heavy) (2)	92	day	$2,531	=	$232,853
Equip. Oper. (oiler)	92	day	$1,091	=	$100,332
Laborers (3)	92	day	$2,668	=	$245,499
Crawler Crane (40 ton)	92	day	$2,626	=	$241,592
Lead, 60' high	92	day	$152	=	$13,984
Hammer, diesel	92	day	$1,212	=	$111,467
Air compressor (600 cfm)	92	day	$964	=	$88,688
50' air hoses (2)	92	day	$60	=	$5,483
Chain saw, gas (36 inches)	92	day	$90	=	$8,280

Materials

Assume that materials can be reused as crew moves from block to block.

Assume 3 sections of trench (one section is from manhole to manhole at approximately 200 length feet) would require sheeting at one time.

Sheeting	24000	SF	$11	=	$270,000
Subtotal				=	**$2,154,273**

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Total surface area of excavation (sidewalls and bottom)	58,080	SF
Number of samples	65	samples
Plus QC samples (10%)	72	samples

Field ISOCS gamma spec unit with Lab!	1	month	$6,000	=	$6,000
Gamma spec analytical cost	72	each	$75	=	$5,400
Shipping	5	each	$200	=	$1,000
Subtotal				=	**$12,400**

Waste characterization sampling

Assume one sample per 500 CY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Total volume for offsite disposal	704	BCY	880	LCY	*Loose factor of 1.25*	
Total samples		2	samples			
Sampling costs based on remedial investigation.						
Radiological Analysis	2	samples	$75	=	$150	
TCLP/TCL	1	samples	$1,200	=	$1,200	
Shipping	5	each	$200	=	$1,000	
Subtotal				=	**$2,350**	

Sewer and Manhole Replacement and Restoration

Sewer pipeline replacement

Pipeline total to be replaced						
12" clay pipeline			150	feet		
15" clay pipeline			200	feet		
24" reinforced concrete pipeline			855	feet		
Duration						
Reference - RS Means 33 41 1360 2010 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2020 for 2017 in Queens, NY						
Reference - RS Means 33 41 1360 2040 for 2017 in Queens, NY						
Production rate is reduced by 40% to account for utilities.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration -12"	150 LF		90 LF/day	=	2	days
Duration -15"	200 LF		90 LF/day	=	3	days
Duration -24"	855 LF		60 LF/day	=	15	days
Total Duration				=	20	days
Labor (for pipe diameters 12"-24")						
Labor foreman	20	day	$467	=	$9,349	
Laborers (4)	20	day	$1,779	=	$35,580	
Equip. Op. (light)	20	day	$579	=	$11,587	
Backhoe Loader (48 HP)	20	day	$366	=	$7,324	
Materials						
Pipeline 12"	150	LF	$17	=	$2,567	
Pipeline 15"	200	LF	$22	=	$4,416	
Pipeline 24"	855	LF	$31	=	$26,710	
Bedding material (6 inches)	4,840	LCY	$52	=	$251,680	
Subtotal				=	**$349,213**	

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Manhole Replacement							
	Duration						
	Reference - RS Means 33 49 1310 0600 for 2017 in Queens, NY (8' deep)						
	Reference - RS Means 33 49 1310 0700 for 2017 in Queens, NY (For depths over 8')						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Number of manholes to 8'	11	each				
	Extra depth	65	VLF				
	Duration for 8' VLF m	11 each		0.7 each/day	=	16	days
	Duration for extra de	65 VLF		5.5 VLF/day	=	12	days
						28	days
	Labor and Materials						
	Manholes to 8'				=	$59,264	
	Extra depth				=	$51,245	
	Subtotal				=	**$110,508**	
Backfill							
	Excavated clean soils testing for backfill						
	Non-contaminated soil above sewer line		4,857	BCY			
	VOC samples	15	each	$75	=	$1,125	
	SVOCs	6	each	$145	=	$870	
	Inorganics	6	each	$85	=	$510	
	PCBs	6	each	$70	=	$420	
	Pesticides	6	each	$65	=	$390	
	Planning and sample collection	6	each	$200	=	$1,200	
	Sample reporting	1	LS	$5,000	=	$5,000	
	Subtotal				=	**$9,515**	
	Common fill needed	*Loose factor of 1.25%*					
	Contaminated soil round and below sewer		704	BCY	880	LCY	
	Common fill	1,126	tons	$26	=	**$29,286**	
	Duration						
	Reference - RS Means 31 23 1613 3080 for 2017 in Queens, NY						
	Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY						
	Production rate is reduced by 80% to account for utilities.						
	Labor rates assume 1.42 overhead rate on top of bare labor rates.						
	Duration (fill)	1,126 LCY		120 LCY/day	=	10	days
	Duration (compact)	9,640 SY		560 SY/day	=	18	days
	Labor						
	Laborers (2)	28	day	$889	=	$24,906	
	Equip. Oper. (medium)	28	day	$608	=	$17,033	
	Front end loader	28	day	$556	=	$15,574	
	Compaction Roller	28	day	$183	=	$5,118	
	Subtotal				=	**$62,631**	

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

07 - Sewer Line Excavation, Removal, and Replacement

Roadway restoration

Road to be replaced			10,000 SF			
			1,112 SY			
Duration						
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY						
Reference - RS Means 32 12 1613 0200 in Queens, NY						
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY						
Production rate is reduced by 80% to account for tight areas.						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration - concrete	1,112 SY		600 SY/day	=	2	days
Duration - binder	1,112 SY		828 SY/day	=	2	days
Duration - wearing	1,112 SY		900 SY/day	=	2	days
Labor						
Labor foreman	6	day	$467	=	$2,805	
Laborers (7)	6	day	$3,113	=	$18,679	
Equip. Oper. (medium) (3)	6	day	$1,824.98	=	$10,950	
Rodman	2	day	$618	=	$1,235	
Cement finisher	2	day	$533	=	$1,065	
Grader	2	day	$966	=	$1,931	
Paving machine	2	day	$2,455	=	$4,910	
Asphalt paver	4	day	$2,235	=	$8,940	
Tandem roller	4	day	$238	=	$950	
Pneumatic wheel roller	4	day	$356	=	$1,423	
Materials						
Concrete (6")	1,112	SY	$41	=	$45,792	
Binder Course	1,112	SY	$23	=	$25,817	
Wearing Course	1,112	SY	$19.10	=	$21,238	
Subtotal				=	**$145,737**	

Duration of sewer line excavation, removal, and replacement is based on sheeting, pipe replacement, and manhole replacement due to concurrency of other tasks.

TOTAL DURATION OF ACTIVITY **140 days**

TOTAL COST FOR SEWER LINE EXCAVATION, REMOVAL, AND REPLACEMENT **$5,037,000**

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

Assume an area of 25 feet by 27 feet with a depth of 4 feet of soils exceed PRGs and needs to be removed from below a concrete slab.

Foundation Removal

Assume foundation is slab-on-grade has a depth of 6 inches and is rod reinforced

Total volume of foundation to remove			675 SF		13 CY
			0.5 feet		

Removal Duration

Reference - RS Means 02 41 1916 0020 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	675 SF		175 SF/day	=	4	days

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	4	day	$467	=	$1,870
Laborers (4)	4	day	$1,779	=	$7,116
Air compressor	4	day	$181	=	$725
Pavement breaker (2)	4	day	$20	=	$82
50' air hoses (2)	4	day	$12	=	$46
Subtotal				=	**$9,839**

Soils Excavation

Total excavation volume of soils

Soil volume	100 BCY

Excavation Duration

Reference - RS Means 31 23 1616 0200 for 2017 in Queens, NY

Production rate is reduced by 20% to account for unknown conditions associated with data gaps for potentially impacted properties.

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration	100 BCY	19 CY/day	=	6	days

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

	Quantity	Unit	Unit Cost		Extended Cost
Labor and Equipment					
Labor foreman	6	day	$467	=	$2,805
Laborers (4)	6	day	$1,779	=	$10,674
Subtotal				=	**$13,479**

Post-excavation sampling

Assume one sample per 900 sq feet. This assumption was made based on experience and a full evaluation of the area as per MARSSIM was not conducted. However, this would be required during the construction period.

Assume samples will be shipped every week during excavation duration.

Excavation perimeter	Sampling Depth		Wall Surface Area
104	4	=	416

Total surface area of excavation sidewalls	416	SF
Total surface area of excavation bottom	675	SF
Number of samples	2	samples
Plus QC samples (10%)	3	samples

Sampling costs based on remedial investigation.

Field ISOCS gamma spec unit with LabSOCS software	1	week	$2,000	=	$2,000
Gamma spec analytical cost	3	each	$75	=	$225
Shipping	1	each	$200	=	$200
Subtotal				=	**$2,425**

Waste characterization sampling

Assume one sample per 500 LCY.

Assume all samples are analyzed for radiological analyses and only 10% analyzed for full TCLP and TCL.

Assume samples will be shipped every week during excavation duration.

Total volume for offsite disposal	100	BCY	125	LCY
Total samples		1	samples	

Sampling costs based on remedial investigation.

Radiological Analysis	1	samples	$75	=	$75
TCLP/TCL	1	samples	$1,200	=	$1,200
Shipping	1	each	$200	=	$200
Subtotal				=	**$1,475**

Backfill

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Common fill needed	100	BCY	125	LCY
=	160	tons		

Duration

Reference - RS Means 31 23 2313 0400 for 2017 in Queens, NY

Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY

Labor rates assume 1.42 overhead rate on top of bare labor rates.

Duration (fill)	125	LCY	100	CY/day	=	2	days
Duration (compa	75	SY	2800	SY/day	=	1	days

Labor and Equipment					
Laborers (2)	3	day	$889	=	$2,668

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CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

08 - Other Impacted Buildings Excavation

Equip. Oper. (medium)	3	day	$608	=	$1,825	
Compaction Roller	3	day	$183	=	$548	
Materials						
Common fill cost includes materials and trucking to site.						
Common fill	160	ton	$26	=	$4,160	
Subtotal				**=**	**$9,202**	

Concrete replacement

Assume backfill will consist of common fill.

Assume backfill will be by hand with roller compaction.

Concrete		13	CY			
Duration						
Reference - RS Means 03 30 5340 4000 for 2017 in Queens, NY						
Labor rates assume 1.42 overhead rate on top of bare labor rates.						
Duration	13 CY		39 CY/day	=	1	days
Labor and Equipment						
Labor foreman	1	day	$467	=	$467	
Laborers (4)	1	day	$1,779	=	$1,779	
Carpenters (6)	1	day	$3,357	=	$3,357	
Rodmen (2)	1	day	$1,234	=	$1,234	
Cement finisher	1	day	$532	=	$532	
Gas engine vibrator	1	day	$28	=	$28	
Subtotal				**=**	**$7,397**	

Duration of excavation is based on duration to accomplish excavation due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY	**6 days**
TOTAL COST FOR OTHER IMPACTED BUILDINGS EXCAVATION	**$44,000**

CDM Smith

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CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

09a - Transportation and Disposal

Construction material calculations presented in Appendix A.

Estimates are budgetary, include transportation to the disposal facility and disposal fee, and were given by I.C.E. Service Group for the year 2019.

Quantity calculation based on existing data.

Assume 0% bulking factor for construction materials (building and sewer).

Assumes 1.9 tons per CY of construction materials.

Assumes 1.6 tons per CY of soils.

Assumes debris to be less than 3'x3'x3'.

Assumes non-radiologically contaminated material/non-hazardous material would be transported to Pennsylvania (IESI/Progressive Waste Solutions).

Assumes radiologically-contaminated material would be transported to Idaho (US Ecology).

Assume radiologically-contaminated material mixed with TSCA waste would go to Texas (Waste Control Specialists).

Type	Quantity	Unit Cost	Extended Cost
Non-radiologically contaminated material	*tons*		
Non-radiologically-contaminated building materials	2,200	$100	$220,000
Sewer - pavement debris	400	$100	$40,000
Radiologically contaminated material	*tons*		
Radiologically-contaminated building materials	2,600	$435	$1,131,000
Pavement debris	1,300	$435	$565,500
Primary Excavation Soils	28,800	$435	$12,528,000
Secondary Excavation Soils	1,500	$435	$652,500
TSCA+Rad Soils	80	$700	$56,000
Sewer - Construction materials	80	$435	$34,800
Sewer - Soils	1,300	$435	$565,500
Decontamination water	*drums*		
Aqueous	1,470	$295	$433,650
Total	**37,860**		**$16,226,950**

TOTAL COST FOR TRANSPORTATION AND DISPOSAL **$16,227,000**

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT		
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017		
	CLIENT: EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

09b - Transportation and Disposal Associated Labor

Assume offsite loading would be performed concurrently to demolition, excavation, and sewer line activities.

Assume 15 trucks could depart the site on a daily basis with a load of 20 tons.

Duration of disposal for demolition						
4,800 tons			300 tons/day	=	16	days
Duration of disposal for excavation						
31,680 tons			300 tons/day	=	106	days
Duration of disposal for sewer materials						
1,780 tons			300 tons/day	=	6	days
Labor and Equipment (during demolition)						
Laborers (2)	16	day	$889	=	$14,232	
Traffic controllers (2)	16	day	$960	=	$15,360	
Hyd. Excavator (3.5 CY)	16	day	$2,401	=	$38,416	
Equip. Op. (heavy)	16	day	$633	=	$10,124	
Subtotal				=	**$78,132**	
Labor and Equipment (during excavation)						
Because production rate of excavation is limited by the number of trucks that can be loaded each day on the site,						
it is assumed that equipment used for the excavation can also be used for loading.						
Labor and Equipment (during sewer line)						
Laborers (2)	6	day	$889	=	$5,337	
Traffic controllers (2)	6	day	$960	=	$5,760	
Crawler loader (3 CY)	6	day	$2,401	=	$14,406	
Equip. Op. (heavy)	6	day	$633	=	$3,797	
Subtotal				=	**$29,299**	
TOTAL COST FOR TRANSPORTATION AND DISPOSAL LABOR ONLY					**$108,000**	

CDM Smith	PROJECT: Wolff-Alport	COMPUTED BY : KK	CHECKED BY: FT
	JOB NO.: 101995.3323.054	DATE : 7/13/2017	DATE CHECKED: 7/14/2017
	CLIENT: EPA		

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

10 - Site Restoration

Backfill

Assume backfill will consist of common fill.

Assume backfill rate of 975 LCY per day.

					Loose factor of 25%			
Common fill needed			18,000 BCY		22,500 LCY			
		=	28,800 tons					
Duration								
Reference - RS Means 31 23 2314 2020 for 2017 in Queens, NY								
Reference - RS Means 31 23 2324 0420 for 2017 in Queens, NY								
Labor rates assume 1.42 overhead rate on top of bare labor rates.								
Duration (fill)	22,500 LCY			975 LCY/day	=	24	days	
Duration (compact)	11,352 SY			2800 SY/day	=	5	days	
Labor								
Laborers (2)		29	day	$889	=	$25,795		
Equip. Oper. (medium)		29	day	$608	=	$17,642		
Dozer (200 HP)		29	day	$556	=	$16,130		
Compaction Roller		29	day	$183	=	$5,301		
Materials								
Common fill cost includes materials and trucking to site.								
Common fill		28,800	ton	$26	=	$748,800		
Subtotal					=	**$813,668**		

Road/Asphalt Replacement

Road to be replaced			39,423 SF				
			4,390 SY				
Duration							
Reference - RS Means 32 13 1325 0020 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0200 for 2017 in Queens, NY							
Reference - RS Means 32 12 1613 0460 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration - concrete	4,390 SY			3,000 SY/day	=	2	days
Duration - binder	4,390 SY			4,140 SY/day	=	2	days
Duration - wearing	4,390 SY			4,500 SY/day	=	1	days
Labor							
Labor foreman		5	day	$467	=	$2,337	
Laborers (7)		5	day	$3,113	=	$15,566	
Equip. Oper. (medium) (3)		5	day	$1,825	=	$9,125	
Rodman		2	day	$618	=	$1,235	
Cement finisher		2	day	$533	=	$1,065	
Grader		2	day	$966	=	$1,931	
Paving machine		2	day	$2,455	=	$4,910	
Asphalt paver		3	day	$2,235	=	$6,705	
Tandem roller		3	day	$238	=	$713	
Pneumatic wheel roller		3	day	$356	=	$1,067	
Materials							
Binder Course		4,390	SY	$23	=	$101,923	
Wearing Course		4,390	SY	$19	=	$83,845	
Subtotal					=	**$230,422**	

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

10 - Site Restoration

Sidewalk Replacement

Assume a 6-inch sidewalk will be installed.

Total area of sidewalk to install			7,819 SF				
Duration							
Reference - RS Means 32 06 1010 0310 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	7,819 SF		1,200 SF/day		=	7	days
Labor							
Laborers (2)		7	day	$889	=	$6,226	
Cement Finisher(2)		7	day	$1,063	=	$7,443	
Carpenter (2)		7	day	$1,119	=	$7,833	
Subtotal					**=**	**$21,502**	
Materials							
Concrete, 4" thick		7,819	SF	$3	=	$25,648	
Subtotal					**=**	**$25,648**	

Topsoil Placement and Seeding

Assume 6 inches of topsoil will be placed on the property.

Topsoil needed			49,560 SF				
			5,507 SY		918 BCY		
depth			0.5 feet		1148 LCY		
Duration of topsoil placement							
Reference - RS Means 32 91 1913 0400 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	1,148 CY		120 CY/day		=	10	days
Duration of fine grading and seeding							
Reference - RS Means 32 92 1913 0310 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	5,507 SY		1,000 SY/day		=	6	days
Labor							
Labor foreman		16	day	$467	=	$7,479	
Laborers (2)		16	day	$889	=	$14,232	
Equip. Oper. (medium)		16	day	$608	=	$9,733	
Backhoe/FE loader		16	day	$658	=	$10,522	
Subtotal					**=**	**$41,966**	
Materials							
Topsoil		1,148	CY	$40	=	$45,920	
Seed, lime, fertilizer		1,148	SY	$4	=	$4,592	
Subtotal					**=**	**$50,512**	

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	FT
JOB NO.:	101995.3323.054	DATE :	7/13/2017	DATE CHECKED:	7/14/2017
CLIENT:	EPA				

Description: FS Cost Estimate for Alternative 4 - Individual Cost Item Backup

10 - Site Restoration

Fencing to secure property

Perimeter requiring fencing		800	LF				
Fencing installation duration							
Reference - RS Means 01 56 2650 0100 for 2017 in Queens, NY							
Labor rates assume 1.42 overhead rate on top of bare labor rates.							
Duration	800 SF			300 LF/day	=	3	days
		Quantity	Unit	Unit Cost		Extended Cost	
Labor and Equipment							
Common building laborers (2)		3	day	$960	=	**$2,880**	
Materials		800	LF	$5	=	**$4,000**	

Final Status Survey

Assume gross gamma measurements and exposure rate measurements will be collected.

Based on previous work completed at the site.

Surface area				58,080 SF			
Gamma exposure rate measurements				8			
Duration							
Assume production rate of 12000 SF per day							
Duration - scan survey	58,080 SF			12,000 SF/day	=	5	days
Duration - exposure rates	8 each			2 each/day	=	4	days
Labor							
Labor and equipment are accounted for in general requirements							
NaI detector		2	week	$160	=	$320	
Borehole probes		2	week	$150	=	$300	
GPS		9	day	$640	=	$5,760	
Final Status Survey Plan		1	LS	$25,000	=	$25,000	
Final Status Survey Report		1	LS	$25,000	=	$25,000	
Subtotal					**=**	**$56,380**	

Duration of restoration is based on duration of backfill, sidewalk placement, and the final status survey due to concurrency of tasks.

TOTAL DURATION OF ACTIVITY **54 days**

TOTAL COST FOR SITE RESTORATION **$1,247,000**

Appendix G

Appendix G
Sewer Pipeline Flow Capacity Calculations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

PROJECT:	Wolff-Alport	COMPUTED BY :	KK	CHECKED BY:	JB
JOB NO.:	101995.3323.054	DATE :	3/1/2017	DATE CHECKED:	3/14/2017
CLIENT:	EPA				

Description: Determination of Combined Sewer System (CSS) flow capacities for use in the cost estimate for a sewer bypass system for the Wolff-Alport Chemical Company Superfund Site cost estimates. The calculations are completed using knowledge collected during the sewer fiberscope investigation during the remedial investigation and Manning's equation for open channel flow.

Information gathered during the sewer investigation

Pipeline Section	Diameter (in)	Diameter (feet)	Material	Length	Start pipe depth (feet amsl)	End pipe depth (feet amsl)
C-1 to I-3	15	1.25	Clay	189	60.28	58.13
I-1 to I-2	12	1	Clay	50	Unknown	58.67
I-2 to I-3	12	1	Clay	20	58.32	58.23
I-3 to I-4	12	1	Clay	50	58.27	Unknown
I-4 to I-5	24	2	Concrete, unfinished	75	Unknown	56.32
I-5 to I-6	24	2	Concrete, unfinished	130	56.29	56.09
I-6 to I-7	24	2	Concrete, unfinished	129	56.19	54.88
I-7 to I-8	24	2	Concrete, unfinished	130	54.88	54.15
I-8 to I-9	24	2	Concrete, unfinished	131	54.25	54.27
I-9 to I-10	24	2	Concrete, unfinished	130	54.22	53.92
I-10 to I-11	24	2	Concrete, unfinished	130	53.24	53.46
I-11 to I-12	24	2	Concrete, unfinished	131	53.37	54.71
I-12 to I-13	36	3	Concrete, unfinished	145	52.71	52.6
I-13 to H-1	36	3	Concrete, unfinished	157	52.6	unknown
H-1 to H-2	36	3	Concrete, unfinished	156	unknown	51.82
H-2 to H-3	36	3	Concrete, unfinished	429	51.79	unknown
H-3 to W-1	36	3	Concrete, unfinished	68	unknown	unknown

Calculations using Manning's equation for open channel flow

Since sewer line is open to the atmosphere at the outlet, Manning's equation for open channel flow applies.
Calculations were completed assuming flow fills three-quarters of the pipe at maximum flow.
as an average of other slopes observed along the portion of the pipeline with known invert elevations.
Assumed slope - 0.0048 *ft/ft*

Pipeline Section	Slope (ft/ft)	Manning's coefficient	A = (ft)	Rh = (ft)	Q = (ft3/s)	Q = (gpm)
C-1 to I-3	0.0114	0.014	0.92	0.3125	5	2159
I-1 to I-2	0.0048	0.014	0.59	0.2	1	669
I-2 to I-3	0.0045	0.014	0.59	0.25	2	749
I-3 to I-4	0.0048	0.014	0.59	0.25	2	776
I-4 to I-5	0.0048	0.014	2.36	1	17	7824
I-5 to I-6	0.0015	0.014	2.36	0.5	6	2781
I-6 to I-7	0.0102	0.014	2.36	0.5	16	7145
I-7 to I-8	0.0056	0.014	2.36	0.5	12	5313
I-8 to I-9	0.0002	0.014	2.36	0.5	2	876
I-9 to I-10	0.0023	0.014	2.36	0.5	8	3406
I-10 to I-11	0.0017	0.014	2.36	0.5	6	2917
I-11 to I-12	0.0102	0.014	2.36	0.5	16	7171
I-12 to I-13	0.0008	0.014	5.30	0.75	13	5758
I-13 to H-1	0.0048	0.014	5.30	0.75	32	14532
H-1 to H-2	0.0048	0.014	5.30	0.75	32	14532
H-2 to H-3	0.0048	0.014	5.30	0.75	32	14532
H-3 to W-1	0.0048	0.014	5.30	0.75	32	14532

Appendix H

Appendix H
RESRAD Results - Evaluation of Soil Cover Thickness Impact on Risk
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY

1. Pathways = External, Soil and Radon

2. With cover at 0.15 m the max industrial worker dose occurs at 1000 years but the risk is lower than at t= zero years because the radon dose dominates at t= 0 and is a mix of radon and external at 1000 years

	Scenarios	5 pCi/g Th-232 Dose (mrem/yr) at T_{max}						Risk
		External	Inhalation	Soil Ingestion	Radon	Plant	Total	
Depth = 0.1524 m	Recreational	1.04E+01	2.00E-02	2.70E-01	7.00E-03	0.00E+00	1.07E+01	2.23E-04
	Industrial	1.19E+01	2.97E-02	3.70E-01	1.24E-01	0.00E+00	1.24E+01	2.45E-04
	Residential	2.18E+01	5.88E-02	1.70E+00	6.40E-01	1.42E+02	1.66E+02	1.37E-03
Depth = .6096 m	Recreational	9.20E+00	2.00E-02	2.50E-01	3.40E-03	0.00E+00	9.47E+00	2.15E-04
	Industrial	1.04E+01	2.79E-02	3.49E-01	6.30E-02	0.00E+00	1.09E+01	2.36E-04
	Residential	1.92E+01	5.50E-02	1.59E+00	3.07E-01	1.41E+02	1.62E+02	1.35E-03
Depth = 1.2192 m	Recreational	1.46E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-02	3.30E-07
	Industrial	1.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-02	3.60E-07
	Residential	3.00E-02	0.00E+00	0.00E+00	0.00E+00	4.44E+01	4.44E+01	2.87E-04

	Scenarios	4 pCi/g Th-232, 1 Pci/g Ra-226 Dose (mrem/yr) at Tmax						Risk
		External	Inhalation	Soil Ingestion	Radon	Plant	Total	
Depth = 0.1524 m	Recreational	9.30E+00	2.00E-02	2.70E-01	6.00E-03	0.00E+00	9.60E+00	1.99E-04
	Industrial	1.11E+01	2.80E-02	4.05E-01	6.81E+00	0.00E+00	1.83E+01	3.47E-04
	Residential	2.02E+01	5.60E-02	1.86E+00	3.46E+01	1.32E+02	1.88E+02	2.33E-03
Depth = .6096 m	Recreational	8.18E+00	1.80E-02	2.57E-01	2.70E-03	0.00E+00	8.46E+00	1.73E-04
	Industrial	9.30E+00	2.60E-02	3.53E-01	4.81E+00	0.00E+00	1.45E+01	3.40E-04
	Residential	1.71E+01	5.17E-02	1.61E+00	2.44E+01	1.25E+02	1.68E+02	1.96E-03
Depth = 1.2192 m	Recreational	1.24E-02	0.00E+00	0.00E+00	3.47E-05	0.00E+00	1.24E-02	3.01E-07
	Industrial	1.40E-02	0.00E+00	0.00E+00	6.21E+00	0.00E+00	6.23E+00	1.70E-04
	Residential	2.58E-02	0.00E+00	0.00E+00	2.41E+01	3.95E+01	6.36E+01	9.97E-04

	Scenarios	5 pCi/g Ra-226 Dose (mrem/yr) at Tmax						Risk
		External	Inhalation	Soil Ingestion	Radon	Plant	Total	
Depth = 0.1524 m	Recreational	4.77E+00	1.40E-02	2.88E-01	3.00E-04	0.00E+00	5.07E+00	1.02E-04
	Industrial	7.71E+00	2.27E-02	5.45E-01	3.36E+01	0.00E+00	4.18E+01	1.06E-03
	Residential	1.37E+01	4.46E-02	2.44E+00	1.66E+02	8.66E+01	2.69E+02	6.79E-03
Depth = .6096 m	Recreational	4.16E+00	1.38E-02	2.70E-01	3.00E-04	0.00E+00	4.44E+00	8.90E-05
	Industrial	4.74E+00	1.90E-02	3.72E-01	2.37E+01	0.00E+00	2.89E+01	7.56E-04
	Residential	8.69E+00	3.80E-02	1.70E+00	1.21E+02	6.22E+01	1.93E+02	4.42E-03
Depth = 1.2192 m	Recreational	3.38E-03	0.00E+00	0.00E+00	1.73E-04	0.00E+00	3.55E-03	2.84E-07
	Industrial	3.84E-03	0.00E+00	0.00E+00	2.37E+01	0.00E+00	2.37E+01	6.47E-04
	Residential	7.00E-03	0.00E+00	0.00E+00	1.20E+02	1.96E+01	1.40E+02	3.48E-03

Parameter	RESRAD Input Industrial	Recreational	Resident
Cover Depth	Variable		
Density of Cover Material (g/cm^3)	1.6	1.6	1.6
Area (m^2)	5.00E+03	5.00E+03	5.00E+03
Contamination Thickness (m)	3.048	3.048	3.048
Length Parallel to aquifer flow (m)	1.10E+02	1.10E+02	1.10E+02
Erosion Rate (m/yr)	6.00E-04	6.00E-04	6.00E-04
Contaminated Zone Hydraulic Conductivity	3.00E+01	3.00E+01	3.00E+01
Contaminated Zone B Parameter	4.05	4.05	4.05
Average Annual Wind Speed (m/sec)	5.36	5.36	5.36
Precipitation (m/yr)	1.174	1.174	1.174
Runoff Coefficient	0.8	0.8	0.8
Saturated Zone Total Porosity	3.90E-01	3.90E-01	3.90E-01
Saturated Zone Field Capacity	1.95E-01	1.95E-01	1.95E-01
Saturated Zone Hydraulic Conductivity	3.34E+03	3.34E+03	3.34E+03

Note: Radon doses and total risk are listed for the time period where the max external dose occurred which was typically between year 200 and year 1000. In some situations where there was a thin soil cover and/or 5 pCi/g of Ra-226 the radon dose and risk from radon would be greater and would occur at year zero. The reason the table is constructed in this manner is to provide information on what the maximum doses from other pathways would be when the radon and plant pathway components are not considered.

Appendix H
RESRAD Results - Evaluation of Soil Cover Thickness Impact on Risk
Wolff-Alport Chemical Company Site
Ridgewood, Queens, NY

Parameter (Cont.)	RESRAD Input		
	Industrial	Recreational	Resident
Unsat Zone 1 Thickness (m)	1.17E+01	1.17E+01	1.17E+01
Unsat Zone 1 soil density(g/cm^3)	1.60E+00	1.60E+00	1.60E+00
Unsat Zone 1 Total Porosity	4.10E-01	4.10E-01	4.10E-01
Unsat. zone 1, effective porosity	3.20E-01	3.20E-01	3.20E-01
Unsat. zone 1, field capacity	2.05E-01	2.05E-01	2.05E-01
Unsat. zone 1, soil-specific b parameter	4.05E+00	4.05E+00	4.05E+00
Unsat. zone 1, hydraulic conductivity (m/yr)	3.00E+01	3.00E+01	3.00E+01
Inhalation Rate (m^3/yr)	7.94E+03	6.45E+03	8.53E+00
Exposure Duration	25	26	26
Indoor Fraction	0.126	0	0.66
Outdoor Fraction	0.126	0.16	0.07
Soil Ingestion Rate (g/yr)	2.50E+01	4.31E+01	5.93E+01
Shielding factor, inhalation	0.4	0.4	0.4
Shielding factor, external gamma	0.4	0.4	0.4
Fruits, vegetables and grain consumption (kg/yr)	0	0	2.04E+02
Leafy vegetable consumption (kg/yr)	0	0	3.62E+01
Drinking water intake (L/yr)	0	0	7.36E+02